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DEPARTMENT OF THE ARMY FIELD MANUAL

**QUARTERMASTER
PETROLEUM DEPOT
COMPANY**

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**HEADQUARTERS, DEPARTMENT OF THE ARMY
JANUARY 1960**

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No. 10-37 }

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., 11 January 1960

QUARTERMASTER PETROLEUM DEPOT COMPANY

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CHAPTER 1

INTRODUCTION

1. Purpose and Scope

a. This manual provides information for the effective utilization of the Quartermaster Petroleum Depot Company (TOE 10-377). It is a guide for officers and enlisted personnel of the company and for other persons concerned with the employment and operation of the company.

b. The manual covers the mission, organization, employment, operations, and administration of the company, its operating platoons, and sections. Appendixes contain a list of references, petroleum conversion equations and formulas, and capacities of pipelines and pump stations.

2. Application

a. Procedures described in this manual reflect policies current at the time of preparation. They are intended to be used as guides and must not be regarded as an inflexible set of rules. Company operation must be adapted to specific situations by intelligent application of basic operating principles.

b. Unless otherwise specified, the material presented is applicable without modification to both nuclear and nonnuclear warfare.

c. Changes in Army organization and concepts may require modification of the information pre-

sented. Users are, therefore, requested to submit recommendations for changes or corrections directly to the Commanding General, Quartermaster Training Command, U. S. Army, Fort Lee, Virginia. Information, guidance, and format for the preparation of recommendations are contained in AR 310-3.

CHAPTER 2

THE COMPANY

Section I. GENERAL

3. Mission

The quartermaster petroleum depot company operates military petroleum terminal and pipeline facilities and provides local distribution of petroleum products. The company provides for receipt, storage, and issue of petroleum; laboratory service for quality surveillance of petroleum products; maintenance of prescribed reserves; and, as required, bulk reduction.

4. Capabilities

a. Storage. The company is capable of operating, at full strength, two petroleum terminals, each with a maximum capacity of 500,000 barrels of petroleum. An additional terminal operating platoon will be authorized when the company is required to operate an additional terminal.

b. Pipeline Operation. The company is capable of operating, at full strength, approximately 90 miles of pipeline and 6 pump stations. When augmented by an additional pipeline platoon, the company can operate an additional 45 miles of pipeline.

c. Bulk Delivery. The company normally operates on the basis of two 10-hour shifts per day, and, at full strength, when operating approxi-

mately 90 miles of pipeline on level terrain, can ship approximately—

- (1) 25,000 barrels of petroleum per day through an 8-inch pipeline; or
- (2) 14,000 barrels of petroleum per day through a 6-inch pipeline.

d. Local Delivery. On the basis of two round trips per day and 75 percent availability, the company is capable of delivering up to 104,000 gallons of petroleum by organic tank truck. It can also ship up to 500,000 gallons by barge, tank truck, and tank car when necessary facilities are provided from command transportation sources.

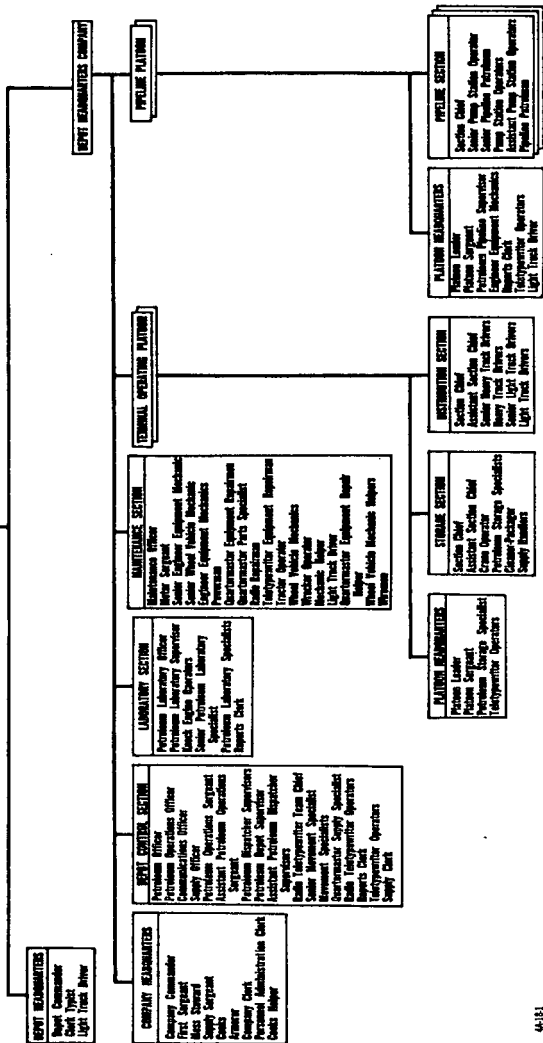
e. Petroleum Handling. Container filling and cleaning capabilities are shown in TOE 10-377. These capabilities may be increased when the company is augmented by a Quartermaster Service Company (TOE 10-67) or an equivalent amount of labor from other sources.

Section II. ORGANIZATION

5. Structure and Composition

The quartermaster petroleum depot company (fig. 1) consists of the depot headquarters and depot headquarters company. Depot headquarters company is organized into company headquarters, depot control section, laboratory section, maintenance section, two identical terminal operating platoons, and two identical pipeline platoons. Each terminal operating platoon consists of platoon headquarters, a storage section, and a

QUARTERMASTER PETROLEUM DEPT COMPANY



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Figure 1. Organizational chart of quartermaster petroleum depot company.

distribution section. Each pipeline platoon consists of platoon headquarters and three identical pipeline sections.

6. Depot Headquarters

Depot headquarters is the command and control agency for the depot operated by the company. It directs, supervises, and coordinates the activities performed by the operating elements of the company as well as by such other units as may be assigned or attached to the depot for the purpose of accomplishing the assigned mission.

7. Depot Headquarters Company

a. Company headquarters performs administration and supply functions, and supervises the training, messing, and security activities of the company.

b. The depot control section advises and assists the depot commander in planning, coordinating, and supervising the petroleum storage and distribution activities of the operating platoons.

c. The laboratory section provides technical assistance on handling, storage, sampling, and identification, and conducts quality surveillance of bulk and packaged petroleum products.

d. The maintenance section provides organizational maintenance for wheeled and tracked vehicles, power-generating and communications equipment, and quartermaster and engineer petroleum equipment assigned to the company.

e. The *terminal operating platoons* supervise the receipt, storage, issue, and distribution of bulk and packaged petroleum products.

(1) Each *storage section* operates a terminal tank farm complex; receives, stores, and issues packaged greases, oils, and lubricants; cleans cans and drums; performs bulk reduction operations; and stores and issues liquid petroleum products.

(2) Each *distribution section* provides for local bulk delivery of petroleum products.

f. Each *pipeline platoon* supervises the operation of and performs organizational maintenance on its assigned portion of the multiproduct pipeline and on three pump stations. Each *pipeline section* operates a pump station and its assigned portion of the pipeline. It also patrols its portion of the pipeline for leaks, fires, sabotage, and pilferage.

Section III. DUTIES OF PERSONNEL

8. General

The duties of company personnel are generally apparent from the job titles listed in TOE 10-377 and the general description of duties set forth in AR 611-201 and SR 605-105-5. In addition, key personnel perform duties peculiar to the operation of the quartermaster petroleum depot company. The duties of these key personnel are outlined in this section.

9. Depot Headquarters

The *depot commander* is responsible for the effective and efficient operation of the petroleum depot. He is responsible for the layout and development of the depot area as well as operations involved in the receipt, storage, issue, and distribution of class III supplies. He develops plans, policies, and procedures for the operation of the depot in accordance with missions and instructions received from higher headquarters. He plans, directs, and supervises the operation and training of the company so that it can perform its assigned mission in the field, accomplish its own administration, maintain military standards of discipline, and defend itself and its installations against enemy attack. While he may assign to subordinates authority for supervising specified aspects of the mission, he retains full responsibility for the general management and proficiency of his unit.

10. Company Headquarters

The *company commander* is responsible to the depot commander for the administration, discipline, training, mess, and security of company personnel. He sees that company personnel are available for duty in the depot headquarters and in the operating elements of the company. He supervises the training of attached personnel. He is assisted by the *first sergeant*, who supervises the activities of the administrative, supply, and mess personnel in the headquarters.

11. Depot Control Section

a. The *petroleum operations officer* is the principal assistant and adviser to the petroleum depot commander for company activities incident to the operation of the depot. As chief of section, he directs, supervises, and coordinates company operations to assure compliance with directives and instructions of the depot commander and/or higher headquarters for the storage and distribution of petroleum and petroleum products. He is assisted by the *petroleum operations sergeant* and *assistant petroleum operations sergeant*, one of whom should be available for duty on each shift.

b. The *petroleum officer* controls the flow of petroleum through the pipeline system over which the company has been assigned jurisdiction. Acting in the capacity of dispatcher for the pipeline system operated by the company, he prepares schedules and issues dispatching instructions to the pump stations and tank farms operated by the company. The extent to which the petroleum officer controls such activities depends primarily upon the specific mission assigned to the company and upon the extent to which the pipeline system has been developed within the theater. In general, however, he will normally receive schedules and dispatching instructions from the headquarters or command charged with responsibility for the intersectional bulk distribution of petroleum. He supervises the *petroleum dispatching supervisors* and *assistant petroleum dispatching supervisors* in the performance of their duties. A petroleum

dispatching supervisor and an assistant petroleum dispatching supervisor operate on each shift.

c. The *communications officer* directs and supervises the installation, operation, and maintenance of company communication facilities. He coordinates communication activities and maintains liaison with staff and area signal personnel. He directs and supervises the communications personnel organic to the company.

d. The *supply officer* supervises stock accounting and control activities incident to the requisitioning, receipt, storage, and issue of petroleum products. He is assisted by the *petroleum depot supervisor*, who supervises the *quartermaster supply specialist* and *supply clerk*.

e. The *senior movement specialist* and the *movement specialists* assist the petroleum operations sergeant in determining requirements for shipping petroleum products and prepare transportation documents to effect these movements.

12. Laboratory Section

The *petroleum laboratory officer* directs the operation of the laboratory and makes appropriate reports and recommendations. He is assisted by the *petroleum laboratory supervisor* who supervises the specialists and clerical personnel assigned to the section.

13. Maintenance Section

a. The *maintenance officer*, assisted by the motor sergeant, supervises and directs the organ-

izational maintenance of organic vehicles, petroleum handling equipment, materials handling equipment, and other specialized company equipment. The *quartermaster parts specialist* requisitions and issues repair parts required for the organizational maintenance.

b. The maintenance officer, with the assistance of the communications officer, also supervises the activities of section personnel who are engaged in the organizational maintenance of company communications equipment.

14. Terminal Operating Platoon

Each terminal operating platoon is commanded by a *platoon leader* who supervises and controls platoon activities in accordance with appropriate orders and instructions. Specific duties include discipline and training of platoon personnel, maintenance of platoon equipment, submission of required reports, and security of platoon installations. Each platoon leader is assisted by a *platoon sergeant* and by a *petroleum storage specialist*. The petroleum storage specialist assists in supervising or conducting inventories and consolidates platoon requirements for operational supplies. He is also safety inspector. The communications personnel organic to each platoon headquarters operate and maintain platoon communications equipment and perform clerical functions as required.

a. -The *section chief* supervises the activities of each storage section. These activities are those incident to the operation of a tank farm and to the

bulk reduction, storage, and issue of petroleum products. The number of personnel assigned to these two major types of activities must be determined on the basis of operational requirements and particular operating conditions. In accordance with the bulk petroleum distribution concept, however, each section should, for planning purposes, be prepared to provide nine *petroleum storage specialists* and six *supply handlers* for tank farm or bulk storage activities. Similarly, each section should be prepared to provide for duties involved in the handling of packaged petroleum products one petroleum storage specialist, nine supply handlers, a *cleaner-packager*, and a *crane operator*, who also function under the supervision of the section chief. The *assistant section chief* supervises the operations of the second shift.

b. The *section chief* of each distribution section supervises truck drivers engaged in the local bulk delivery of petroleum by organic tank trucks and semitrailers. The *assistant section chief* acts as vehicle dispatcher.

15. Pipeline Platoons

a: Each pipeline platoon is commanded by a *platoon leader* who directs and supervises the operation of assigned pipeline sections. He is assisted by a *platoon sergeant* and *petroleum pipeline supervisor*. *Engineer equipment mechanics* are provided to perform organizational maintenance on pipeline and pump station equipment.

b. A section chief supervises the activities of each pipeline section. These activities include the operation of a pump station and an assigned portion of pipeline. Each section-chief is assisted by a *senior pump station operator* and a *senior pipeline patrolman* who supervises the activities of the assigned pump station operators, pipeline patrolmen, and assistants.

Section IV. EQUIPMENT

16. Vehicles

a. The company is provided 5-ton truck tractors with 5,000 gallon semitrailers, and 1,200-gallon tank trucks. These vehicles are used to transport bulk petroleum products required locally. Each type truck is equipped with a gasoline pump assembly for emergency loading and for dispensing and transferring petroleum products. Each truck is also equipped with a filter segregator kit for separating water and solids from the fuel.

b. Truck-mounted pipeline construction equipment sets are used for organizational maintenance of pipelines.

c. Truck-mounted shovel cranes, with boom, are provided for loading and unloading packaged petroleum products, and for maintenance of facilities.

d. Rough-terrain forklift trucks, with drum-handling attachments, are used for handling packaged petroleum products.

e. A full-tracked, diesel-driven tractor is used for fire fighting purposes, maintenance of fire walls, ditching around storage areas, towing disabled vehicles, and for off-road operation in rough terrain and unimproved areas.

f. Cargo, dump, and utility trucks are used for transporting personnel, equipment, materiel, and supplies.

g. A medium wrecker truck is used for towing disabled or inoperative vehicles of the organization.

17. Petroleum Handling Equipment

a. The company is equipped with gasoline-dispensing pumps of varying capacities. These pumps are used to transfer petroleum to or from storage tanks, tank cars, tank trucks, and semi-trailers. They can also be used for can and drum filling, in filling station operations, and in conjunction with other equipment in the operation of fuel system assemblages.

b. The company is provided with collapsible tanks for storing liquid fuels. Five-gallon cans and 55-gallon drums to be used for packaging operations will be obtained through supply channels.

c. A truck-mounted air compressor is used for quick air venting of rigid storage tanks prior to cleaning, and for cleaning steel surfaces of tank and pipe prior to painting.

d. The portable petroleum testing kits contain gaging and sampling equipment, and testing ap-

paratus. The gaging equipment is used for determining the contents of petroleum storage tanks and the temperature of the contents; and the testing apparatus for the performance of a limited number of tests for quality of petroleum products in the field.

e. The company is provided with fuel can and drum cleaning machines. These machines consist of sedimentation tanks and 50-g.p.m. dispensers. Cradles and cradle valves are mounted on each tank for cleaning 5-gallon cans. Each sedimentation tank is equipped with a special drum washer assembly for cleaning 55-gallon drums.

18. Maintenance

a. The petroleum depot company commander is responsible for the organizational maintenance of equipment used by the company. He is responsible for specific organizational maintenance on pipelines, pump stations, and storage tanks, as follows:

- (1) Minor repair work, cleaning, preservation, lubrication, scheduled preventive maintenance and minor adjustments; external and internal cleaning, including ventilating, caulking, and peening of bolted tanks; and maintenance of camouflage.
- (2) Unit replacement of exposed sections of grooved pipeline and couplings; repair of small leaks with bolted clamps; and other repairs not involving the use of

construction or special handling equipment.

- (3) Repair or replacement of assemblies not requiring that basic equipment be evacuated or pump cover removed, and which can be performed with authorized tools and equipment.

b. The Corps of Engineers performs field and depot maintenance on pipelines, pump stations, and rigid construction storage tanks.

CHAPTER 3

OPERATIONS

Section I. CONCEPT

19. General

The quartermaster petroleum depot company is a primary operating element of the agency which controls theater intersectional and inter-zonal bulk petroleum storage and distribution facilities. The company is a key link in the theater petroleum distribution system by which petroleum is supplied in bulk as far forward as possible. This embodies the maximum utilization of port facilities for the receipt of bulk petroleum by submarine line or dockside berthing of tankers, with pipelines as a principal means of moving bulk petroleum overland in a theater of operations.

20. Assignment

The company can be assigned to the theater army logistical command or field army. It may be attached to Headquarters and Headquarters Detachment, Quartermaster Battalion (TOE 10-536) or other designated quartermaster headquarters.

21. Employment

The company, or its operating elements, is employed to operate multi-product pipelines (or portions thereof) and a maximum of two petro-

leum pipeline terminals, including tank farms, pump stations, and related petroleum storage facilities. It may be so employed at petroleum ports of entry and as required in the communications zone and combat zone. The petroleum intersectional service will normally exercise operational control over terminal operations.

a. When employed in the army area, the company, or its operating elements may—

- (1) Operate a petroleum depot and be charged with a storage and/or reserve mission.
- (2) Operate, under the operational control of the petroleum intersectional service, pipeline and pipehead terminal facilities of the military petroleum pipeline system.
- (3) Operate, under the operational control of the army quartermaster, petroleum facilities considered to be a part of the field army petroleum distribution system.

b. When a requirement for pipeline operations does not exist, the pipeline platoons of the company may be detached and utilized in other areas as required. Conversely, when additional pump stations are required, additional pipeline operating personnel may be added to fulfill this requirement.

22. Related Units

a. Quartermaster. Quartermaster units with a mission of providing petroleum supply support to

ultimate users can normally be regarded as the petroleum depot company's principal customers. This mission generally involves the establishment and operation of petroleum supply points, including convoy refueling points and filling stations; temporary bulk storage and bulk transfer facilities; and bulk reduction activities, as required. Such functions may be performed by quartermaster direct and general support organizations; quartermaster supply depot units; or, as is currently the case, by quartermaster petroleum supply companies. The Quartermaster Service Company (TOE 10-67) and the Quartermaster Service Organization (TOE 10-500) also make contributions to the accomplishment of this company's mission. The former provides military labor. The latter makes available appropriate administrative, supervisory, and technical teams or detachments.

b. Engineer. Construction and field maintenance of overland petroleum pipeline systems, installation and field maintenance of tanker and barge unloading facilities, and erection and repair of steel-bolted storage tanks are among the functions that may be performed in support of quartermaster petroleum depot company operations by the Engineer Pipeline Company (TOE 5-377). Additional engineer assistance may be provided in the form of firefighting teams from the Engineer Service Organization (TOE 5-500).

c. Transportation. The transportation corps

will provide line haul transportation for movement of bulk POL by means other than pipeline.

d. Signal. Appropriate signal corps units provide the signal support required for the operation of the petroleum distribution system, to include installation, field and higher echelon maintenance, extension, and reconstruction.

e. Other. Mess and automotive maintenance detachments and helicopters and light aircraft for use in aerial patrol of the pipeline may be provided, when required.

Section II. PREPARATION FOR OPERATIONS

23. Operating Sites

The quartermaster petroleum depot company must be prepared to locate in a variety of operating sites within the theater of operations. The site may consist of—

a. A partly or totally constructed pipeline system, pipeline terminal, and tank farm constructed by the Corps of Engineers.

b. A refinery (intact or partly demolished) with its attendant tank farm system in occupied areas.

c. An undeveloped area selected by higher headquarters to become future bulk storage centers for petroleum products, dispensing facilities, and bulk product delivery points.

d. A pipehead terminal or storage and distribution location in a forward area.

24. Site Selection

a. *General.* Higher headquarters determines the general area for the petroleum depot company and the location of such fixed facilities as pipelines, pump stations, and tank farms. Within this operating area, the depot commander determines specific sites for the bivouac area, laboratory, maintenance facilities, storage of packaged items, and for issue of bulk petroleum products. Site selection factors include the following:

- (1) *Terrain.* Terrain features that provide good cover and concealment minimize the danger of enemy observation and attack. The ground should be level and well drained and should be paved or graveled to permit vehicle traffic to move easily in all types of weather. The area should have good air circulation to minimize a dangerous collection of fumes.
- (2) *Dispersion.* Within the limits of efficient operations, provision should be made for dispersion of supplies and equipment to minimize loss from the impact of mass-destruction weapons.
- (3) *Camouflage.* The most effective measures possible for altering or disguising the appearance of the installation should be utilized. Natural features of the terrain and landscape should be exploited. Camouflage procedures are described in FM 5-20.

(4) *Transportation nets.* The site must be located with adequate access to transportation nets, roads, and rail lines.

b. Tank Farms. Tank farms are located to provide storage for bulk petroleum products. The tank farm area should be large enough to provide tank dispersion and provide for future tank farm expansion. Defilade for tanks and small tank clusters and natural camouflage are desirable. The tank farm should be accessible by road and rail to permit easy movement of equipment and supplies. Tank farms should not be located on higher ground than other installations where leaks or fires could become a hazard.

c. Pump Stations. Pump stations are located along pipelines and are normally spaced 10 to 20 miles apart, depending on the hydraulic design of the pipeline and terrain features. The site for pump stations should take advantage of available natural cover and camouflage, and permit proper spacing of equipment for fire prevention and security. The site should have good drainage. Recessed areas which permit fumes to form vapor pockets should be avoided. Troop housing should be 100 to 200 feet from the pump station.

25. Setting-Up Operations

a. Terminal and pipeline equipment such as steel storage tanks, pipelines, pump stations, valves, manifolds, and loading platforms are installed by the Corps of Engineers.

b. Joint testing of new, renovated, or repaired

petroleum pipelines and terminals, when placing these facilities in operation for the first time, should be standard practice. Joint testing as used here means active participation of both construction agency(s) and operating agency(s). In most instances this would involve Engineer, Quartermaster, and Signal units. In certain instances it may include civilian contractors. Its advantages are:

- (1) Early orientation and training of operating personnel to facilitate subsequent operation and maintenance.
- (2) Positive knowledge on the part of all concerned agencies as to deficiencies detected and corrective action taken.
- (3) Smoother transition from test to operational phase.

c. Arrangements for joint inventory and testing are the responsibility of the commanders of the construction and operating agencies and should be worked out locally through the inter-sectional and interzonal petroleum service.

d. Prior to testing and before acceptance of new facilities, complete plans, maintenance requirements, and operating characteristics of the line should be made available to the receiving agency.

e. Equipment organic to the petroleum depot company, such as the 225-g.p.m. gasoline dispensing pump, the 50-g.p.m. gasoline dispensing pump, and the fuel can and drum cleaning ma-

chine are set up according to instructions contained in the TM 10-1100-series.

26. Obtaining Operating Supplies

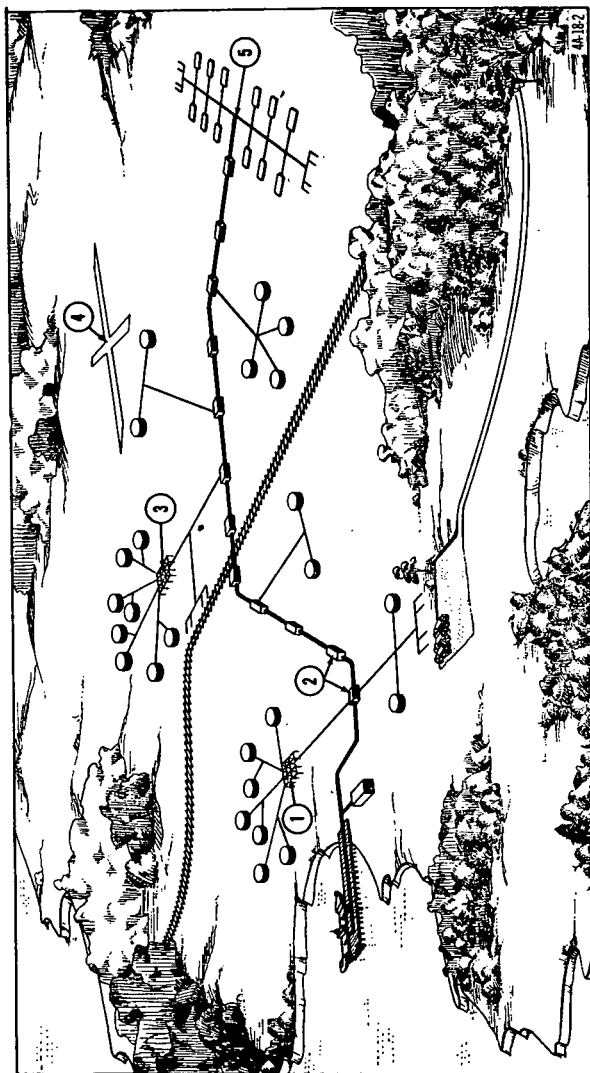
The petroleum depot commander is responsible for seeing that the company is provided with sufficient tools, parts, and supplies to carry out its mission. The quantities requisitioned will be based on authorized allowances, consumption records, and estimated petroleum-handling activities.

Section III. METHODS OF OPERATION

27. Terminals

a. Petroleum pipeline terminals (fig. 2) are installations that provide storage and distribution facilities for the efficient operation of the petroleum supply system. Terminals normally consist of storage tanks, tank farm manifolds, a central pump station, and loading racks. Figure 3 is a schematic drawing of a typical terminal, permitting the flow of petroleum products in any direction. Terminals may be located at a port of entry (base terminal), along a pipeline (intermediate terminal), or at a pipehead (pipehead terminal). Wherever located, terminals operate fundamentally in the same manner.

b. Each of the two terminal operating platoons of the petroleum depot company may operate separate terminals, or may work together in the operation of one terminal, depending upon the mission of the company and the size and dispersion requirements of terminal operating facilities.



1 Base terminal 2 Pump station 3 Terminal 4 Air terminal 5 Pipehead terminal
Figure 2. Petroleum pipeline terminals in a theater of operations.

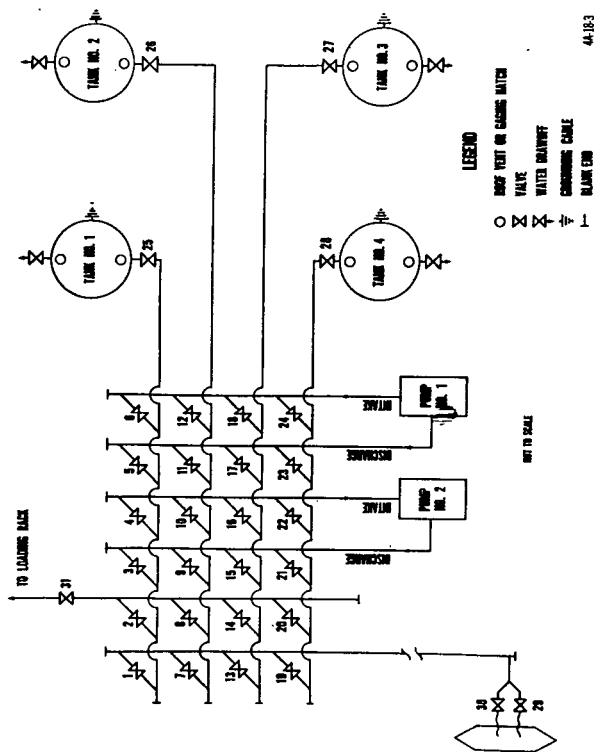


Figure 3. Schematic diagram of a terminal.

c. The terminal working day may be divided into two ten-hour shifts, involving all personnel of the terminal operating platoons and any additional assigned labor. Each shift is supervised by a noncommissioned officer.

d. Quality surveillance of petroleum products entering and leaving the terminal is conducted by laboratory section personnel and coordinated through the dispatcher of each shift.

- (1) The dispatcher makes certain that the laboratory receives the required samples promptly.
- (2) The dispatcher is furnished the laboratory reports on tests on the sample for necessary action.
- (3) Normally, the dispatcher controls the start and stop of pumping operations without informing higher headquarters, provided there is no violation of the daily pump order.

e. Control of the product and time-pumping operations are under the immediate supervision of the dispatcher in charge of the terminal work shift. He is informed hourly of every stage of the operations in each area of the terminal. At the conclusion of each work shift, the dispatcher transmits through channels to the depot control section the required reports for the work shift. A guide to flow control operations is given in table I.

Table I. Flow-Control Operations

Pumping from—	To—	With pump	Open valves
Tanker	Tank No. 1	1	29, 19, 24, 5, 25
Tanker	Tank No. 2	1	29, 19, 24, 11, 26
Tanker	Tank No. 3	1	29, 19, 24, 17, 27
Tanker	Tank No. 4	1	29, 13, 18, 23, 28
Tanker	Tank No. 1	2	29, 19, 22, 3, 25
Tanker	Tank No. 2	2	29, 19, 22, 9, 26
Tanker	Tank No. 3	2	29, 19, 22, 15, 27
Tanker	Tank No. 4	2	29, 13, 16, 21, 28
Tank No. 1	Tank No. 2	1	25, 6, 11, 26
Tank No. 1	Tank No. 3	1	25, 6, 17, 27
Tank No. 1	Tank No. 4	1	25, 6, 23, 28
Tank No. 1	Loading rack	1	25, 6, 23, 20, 31
Tank No. 1	Tank No. 2	2	25, 4, 9, 26
Tank No. 1	Tank No. 3	2	25, 4, 15, 27
Tank No. 1	Tank No. 4	2	25, 4, 21, 28
Tank No. 1	Loading rack	2	25, 4, 21, 20, 31
Tank No. 2	Tank No. 1	1	26, 12, 5, 25
Tank No. 2	Tank No. 3	1	26, 12, 17, 27
Tank No. 2	Tank No. 4	1	26, 12, 23, 28
Tank No. 2	Loading rack	1	26, 12, 5, 2, 31
Tank No. 2	Tank No. 1	2	26, 10, 3, 25
Tank No. 2	Tank No. 3	2	26, 10, 15, 27
Tank No. 2	Tank No. 4	2	26, 10, 21, 28
Tank No. 2	Loading rack	2	26, 10, 21, 20, 31
Tank No. 3	Tank No. 1	1	27, 18, 5, 25
Tank No. 3	Tank No. 2	1	27, 18, 11, 26
Tank No. 3	Tank No. 4	1	27, 18, 23, 28
Tank No. 3	Loading rack	1	27, 18, 23, 20, 31
Tank No. 3	Tank No. 1	2	27, 16, 3, 25
Tank No. 3	Tank No. 2	2	27, 16, 9, 26
Tank No. 3	Tank No. 4	2	27, 16, 21, 28
Tank No. 3	Loading rack	2	27, 16, 21, 20, 31
Tank No. 4	Tank No. 1	1	28, 24, 5, 25
Tank No. 4	Tank No. 2	1	28, 24, 11, 26
Tank No. 4	Tank No. 3	1	28, 24, 17, 27
Tank No. 4	Loading rack	1	28, 24, 17, 14, 31

Table I. Flow-Control Operations—Continued

Pumping from—	To—	With pump	Open valves
Tank No. 4	Tank No. 1	2	28, 22, 3, 25
Tank No. 4	Tank No. 2	2	28, 22, 9, 26
Tank No. 4	Tank No. 3	2	28, 22, 15, 27
Tank No. 4	Loading rack	2	28, 22, 15, 14, 31

28. Pipeline Operations

In a military pipeline, the tanks, pumps, and tubing form a single closed system usually containing large quantities of petroleum products in the process of transport.

a. Control of Operations. Each pipeline platoon of the petroleum depot company operates an assigned sector of the military pipeline system under control of the petroleum officer, who controls the starting and stopping of all pump operations. He is provided with continuous and exclusive communication with depot headquarters and pump stations of the pipeline platoons. TM 10-1112 provides detailed information on scheduling and dispatching petroleum products through a military pipeline system.

b. Delivery Procedure.

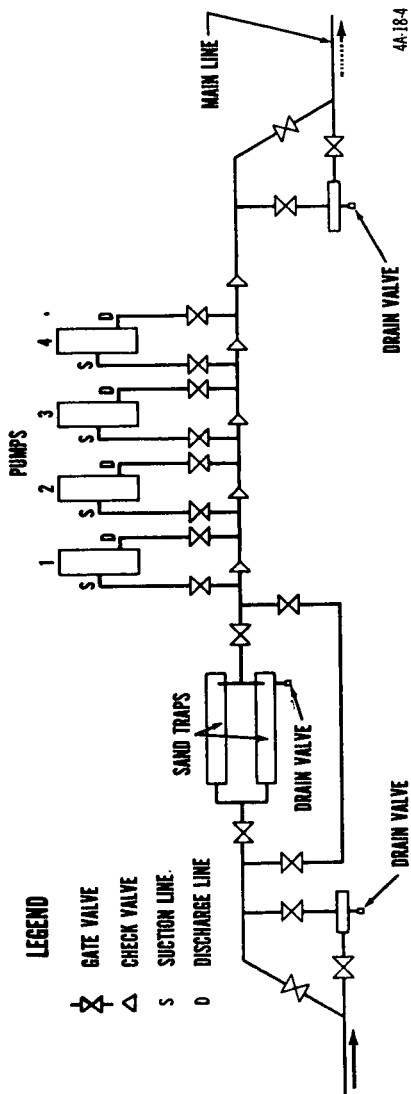
- (1) Before the petroleum product is drawn from storage for delivery through the pipeline, it is sampled and tested by the laboratory section. Upon receiving clearance from the laboratory that the product meets specifications, the dispatcher

may then approve the product for delivery to the pipeline.

- (2) When quality clearance is received by the dispatcher, he publishes a definite time for the start of a tender (batch) of petroleum products from storage through the pipeline. Each pipeline platoon headquarters and pump station is provided information on the type of product to be pumped, amount of product in the tender, the time the head and tail of the tender is scheduled to arrive at pump stations and installations, pressure to be maintained, and any other information required.

c. Pump Station Operation. The standard pipeline pump station with four centrifugal pumps is manifolded so that all four pumps operate in series (fig. 4). Under normal conditions, only three pumps are used with the fourth in reserve for emergency operations and to permit maintenance of each pump.

- (1) *Pump station crews.* One pipeline section normally operates one pump station. Each pipeline section is capable of operating a pump station 24 hours a day.
- (2) *Rotation of pump units.* As a pump station normally operates on three pump units, with one in reserve, alternation of the reserve status among the four pumps will permit maintenance of each pump without shutting down the station.



4A-18-4

Figure 4. Schematic diagram of pump station.

The usual procedure in rotating pump units to reserve is to make the change at the beginning of each shift.

- (3) *Station reporting.* As each interface between batches passes his station, the station operator notifies the pipeline platoon headquarters or petroleum officer. Each pump station sends hourly reports on pump station operations to the pipeline platoon headquarters and petroleum officer.

d. Patrolling the Pipeline. Breaks in the pipeline or major leaks are usually detected by pump station operators from suction and discharge pressure readings or from the change in the normal sound of pump engines. Pump station operators should investigate immediately any unexpected sounds of pump engines. The main purpose of patrols is to detect actual or potential leaks and breaks in the lines; secondarily, patrols serve to discourage sabotage and pilferage. Patrol schedules are irregular to discourage saboteurs and thieves.

- (1) *Ground patrols.* Where the pipeline route is visible and accessible from the road, pipeline patrolmen-repairmen may patrol the pipeline by motor vehicle. Motor patrolling is quicker, and hence may be more frequently done than by foot. Since motor patrolling does not afford close inspection of the pipeline, it supplements foot patrolling. Patrol-

men use truck radios for communication with pump stations. They also carry tools, repair couplings, and leak clamps for minor organizational repairs to the pipeline.

- (2) *Air patrols.* Patrol by helicopter or light aircraft is useful as a supplement to other means, especially where the pipeline does not follow roads. Efficiency of air patrolling depends on the skill and experience of the observer in identifying leaks and trouble spots. Dead or withered vegetation and unusual discoloration of the ground are spotted by air patrols as indicating possible leaks.

29. Bulk Reduction Operations

Bulk reduction is performed by the storage section of each terminal operating platoon of the petroleum depot company. Operations may be centralized when the company is functioning as an integral unit; dispersed when the platoons are each operating a separate terminal. In either case, the bulk reduction area is organized into three subareas: drum and can filling, drum and can cleaning, and storage. Normally, bulk reduction constitutes but a small portion of the operations of the petroleum depot company. When the tactical and logistical situation requires, however, the company may be called upon to fill drums and cans in large quantities. Drum and can filling and cleaning procedures described in TM 10-1101

should be thoroughly and rigorously applied by personnel of the petroleum depot company.

30. Distribution Operations

a. The distribution section of each terminal operating platoon is responsible for the vehicular delivery of bulk petroleum products within the terminal area and to supported units in local areas. Tank trucks and semitrailers are normally filled at the terminal loading platforms. Normally, the vehicle drivers make local delivery and dispense gasoline from the organic 5,000-gallon semitrailers to 1,200-gallon tank trucks or collapsible tanks of supported units. Organic 1,200-gallon tank trucks can distribute directly into collapsible tanks or vehicles. Dispatchers of the operations section are responsible for scheduling movement.

b. When required by the tactical situation or until a bulk distribution system becomes operative, additional flexibility can be provided by use of a dispensing manifold constructed from equipment organic to the company. Through the use of the manifold, petroleum can be transferred from 55-gallon drums to bulk containers. Details on construction and employment are described in TM 10-1101.

31. Operations Under Unusual Conditions

a. *Arctic Operations.* Arctic ports normally are icebound in winter, and depots located inland may be snowbound. It will be necessary, therefore, to take advantage of the summer season for the stockpiling of supplies of petroleum products.

- (1) *Frost and permafrost.* Frost ground is soil subject to seasonal freezing and thawing. Permafrost is a layer of permanently frozen ground beneath the earth's surface and which is not subject to seasonal thawing. The swelling and settling of the ground during thaws frequently causes landslides and ground cleavages. The first preventive measure against damage from thawing is proper site selection. If needed, advice should be obtained from the Corps of Engineers on terrain best suited for the placement of equipment and supplies and for methods of blocking, bracing, and drainage in anticipation of damage. Close inspection of the installation during the first days of thaw is another safeguard. A section of pipeline that appears to be buckling should be separated or reinforced; and a storage tank that appears to be settling should be drained immediately.
- (2) *Snow.* Storage tanks, pump stations, and complicated manifolds with their exposed valves must be protected against drifts and heavy snowfalls. Open storage areas must be properly identified before the rows of cans and drums are completely covered by snow.
 - (a) *Snow fences.* Erection of snow fences is the simplest method of controlling

drifts. Snow fences should be placed about all terminal pipelines, storage tanks, and pump stations. Fences are most effective if transverse to prevailing winds. Snow fences may be improvised by using standing brush, by building snow walls, or by interlacing branches.

- (b) *Snow traps.* A snow trap consists of one or more trenches or ditches, plowed parallel to the structure being protected, in locations where snow fences would otherwise be erected. On the windward side of each trap, a bank is built from 5 to 6 feet high. Snow traps must be built before the ground hardens.
 - (c) *Snow markers.* Snow markers are long poles placed into the ground along the rows of packaged products in the canning area. They serve to identify the position and type of product buried by the snow. A schematic diagram of the canning area should be used during the season of snows to indicate the position of each marker and the type of product it represents.
- (3) *Ice.* The perpetual condensation of water within terminal equipment creates the serious problem of frost lock, particularly on the above-ground storage tanks. The pressure and vacuum vents and

water drawoffs are common places for water to freeze and lock equipment. Vents should be examined and defrosted often, as pumping against a frozen vent may create enough vacuum to collapse a tank. A water drawoff can be prevented from freezing and icing by wrapping with felt or burlap. A frozen water drawoff is usually cracked, and the contents of the tank should be withdrawn before any attempt is made to defrost or repair the valve.

(4) *Fluid flow.*

(a) *Viscosity and temperature.* The viscosity of all low-flash point fuels is such that the fuels are pumpable throughout the year. Diesel and fuel oils, with maximum pour points ranging from -10° F. to 30° F., must be heated before pumping is attempted if the temperature falls below the pour point.

(b) *Heating systems.* Heating systems of steam pipes placed in or near storage tanks or pump stations are used to raise the temperatures of high viscosity petroleum products and make them flow in cold climates.

(5) *Gaging.* In computing the volume of a petroleum fluid in a 3,500-gallon or larger container, the hydrometer reading at an observed temperature must be cor-

rected to the API gravity reading at 60° F. A multiplier is then obtained to adjust for expansion or contraction of the product (app. VI).

b. Tropic Operations.

- (1) *Evaporation losses.* Evaporation losses of volatile stocks, such as gasoline, will be high in tropical regions. They are caused by changes in temperature inside the tank and result in alternate expulsion of vapor and induction of air. Evaporation cycles in above-ground tanks may occur several times a day if there are successive periods of sunlight, shade, or rain. Evaporation losses may be lessened by covering vents with moistened burlap and spraying or shading tanks.
- (2) *Condensation.* Water condensation in pipelines and storage tanks presents a formidable problem in the tropics. Rigid control methods must be enforced to keep such condensation at a minimum.
- (3) *Corrosion.* Corrosion of pipelines is accelerated by salt water and salty air. It may be controlled by applying protective coatings to surface lines and cathodic protection to buried lines.

Section IV. RECORDS AND REPORTS

32. Production Records

The terminal operated by the company makes daily issues of petroleum to meet needs of sup-

ported units. Initially, it may be necessary for supported units to transmit requirements in accordance with procedures developed by higher headquarters. These requirements may be placed by TWX, telephone, or other means of communication. Ultimately, the terminal may make distribution on the basis of issue experience, consumption factors, and other data. Consequently, production records reflecting operations of the quartermaster petroleum depot company will depend upon specific operating conditions. The records discussed below are indicative of those that may be used to develop and maintain sufficient information on a daily, weekly, or monthly basis. Some may be prepared for transmission to the petroleum intersectional service. Others may be submitted to the command quartermaster as required. Some may be required for historical purposes only as automatic data processing equipment and other considerations permit establishment of centralized stock accounting and/or inventory control agencies and automatic-type resupply procedures.

a. Tank Farm Intake Record. The Tank Farm Intake Record, DA Form 10-234, tabulates the flow of petroleum from the dock area (or other point of entry) to the storage tank area. The various columns of the form (fig. 5) are self-explanatory, except that notice should be taken of column *g*, "Net U.S. gallons at 60° F.". This column represents the corrected volume present in tanker or tank car before pumping begins.

When a vessel is being gaged by a crew gager, an individual from the tank farm (usually a gager) will be present to audit the results. In the event of any difference of opinion as to the quantity or quality of a product to be pumped, the question will be resolved by the petroleum depot commander before the order to start pumping may be given.

b. Tank Farm Outturn Record. The Tank Farm Outturn Record, DA Form 10-235, tabulates the flow of petroleum from the storage tank area to the loading rack area. This record (fig. 6) is used when shipments from the tank farm are consigned to outgoing vessels, tank cars, or tank trucks. The record is also used when the product is being transferred from the dock area to the loading rack area, bypassing the terminal storage tanks in emergencies.

c. Pump Station Hourly Operations Record. The Pump Station Hourly Operations Record, DA Form 10-236, tabulates the flow of petroleum passing through the pump station on a 24-hour basis. Notice should be taken of the column *f* of the form (fig. 7) captioned "Other", which may show whether a product has been shipped through the pump station, bypassing terminal storage at that point. This column is checked when the tank farm acts as a booster pump station for a pipeline. This record will be used by pipeline pump stations as an hourly record.

d. Storage Tank Gage Record. The Storage Tank Gage Record, DA Form 10-237, is used

PETROLEUM PRODUCTS TANK FARM INVENTORY RECORD (FM 10-77)										STATION				DATE	
67TH QM PETROL DEPOT CO										VIC LYONS				20 APR 59	
SHIP- MENT NO.	SHIPPER TO	VESSEL OR CAR		CAPACITY (U.S. GALLONS)	OUTAGE OR IMMAGE		WATER OR SEDIMENT		GROSS TOTAL (U.S. GALLONS)	AVERAGE TEMP.	MULTIPLIER COEFFICIENT EXPANSION	NET U.S. GALLONS WT 5	PRODUCT OR GRADE	SAMPLE NO.	
		INITIALS	NUMBER		INCHES	GALLONS	INCHES	GALLONS							
1635	32/PETROL SUP CO	TCX	5,870	10,100	0	0	0	0	10,100	68	.9960	10,060	D-50	59-397	
1645	32/PETROL SUP CO	TCX	5,912	10,100	0	0	0	0	10,100	68	.9960	10,060	D-50	59-398	
1655	32/PETROL SUP CO	TCX	5,839	11,500	0	0	0	0	11,500	70	.9950	11,443	D-50	59-399	
1665	32/PETROL SUP CO	TCX	6,724	11,500	0	0	0	0	11,500	69	.9955	11,448	D-50	59-400	
1675	32/PETROL SUP CO	TCX	10,079	9,000	0	0	0	0	9,000	72	.9940	8,946	D-30	59-401	
1685	32/PETROL SUP CO	TCX	21,130	9,000	0	0	0	0	9,000	72	.9940	8,946	D-30	59-402	
7															
8															
9															
10															
11															
12															
13															
14															
15															
TOTALS					NAME AND GRADE OF OPERATOR		TOTAL		NAME AND GRADE OF BASES (FORM 10-77)		60,903				
NONE					HELMUT G. MOSER CPL.		61,200		MARION A. PARRISH, PFC.						
					SIGNATURE OF OPERATOR		SIGNATURE OF ALLER								
					Helmut G. Moser		Marion A. Parrish								

DA FORM 10-235

Figure 6. Tank farm outturn record.

PETROLEUM PRODUCTS PUMP STATION HOURLY OPERATIONS RECORD										DATE	10 APR 59
PUMP STATION NUMBER										2	
67 TH QM. PETROL DEPOT CO										Vic LYONS	
BATCH NO.	TIME	ORDER OF DESTINATION			LINE TEMP. °F	PUMP STATION PRESSURE		PRODUCT OR GRADE	GALLONS THIS HOUR	TOTAL GALLONS PUMPED	TOTAL SAMPLES PUMPED
		STORAGE TANK	ON	OFF		INCHES (PSI)	PSI				
1	744	0700			OverLand	46	20	470			
2		0800			OverLand	46	19	468	33,000	33,000	785
3		0900			OverLand	46	20	470	33,000	66,000	1571
4		1000			OverLand	47	20	470	33,000	99,000	2357
5		1100			OverLand	48	18	466	33,000	132,000	3142
6		1200			1016						
7	1300	4	✓		OverLand	48	18	468			
8	1400	4	✓		OverLand	48	20	470	33,000	33,000	785
9	1500	4	✓		OverLand	49	20	470	33,000	66,000	1571
10	1600	5	✓		OverLand	49	20	470	33,000	99,000	2357
11	1700	5	✓		OverLand	49	20	470	33,000	132,000	3142
12	1800				OverLand	48	15	465			
13	1900				OverLand	47	20	470	32,300	32,300	769
14	2000				OverLand	47	20	470	32,500	64,800	1542
15	2100				OverLand	47	20	470	32,500	97,300	2316
16	2200				OverLand	46	20	470	32,500	129,800	3090
17	2300				OverLand	46	20	470	32,500	162,300	3864

DA FORM 10-236

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when receiving petroleum into a storage tank or discharging petroleum from a storage tank. Information contained on the storage tank gage records (fig. 8) for a 24-hour period can be quickly tabulated to reveal the tank farm inventory of bulk petroleum products.

e. Daily Issues of Gasoline and Oils. Daily Issues of Gasoline and Oils, DA Form 10-118, may be used to tabulate the issue of petroleum to supported organizations. It may also be used to record issues of petroleum to vehicles at company-operated filling stations and for other services provided by the company.

f. Monthly Abstract of Issues of Gasoline, Oils, and Operating Supplies. The Monthly Abstract of Issues of Gasoline, Oils, and Operating Supplies, DA Form 10-117, is compiled from daily records of issues of gasoline and oil. This form is illustrated in figure 10.

g. Package Area Inventory. The Package Area Inventory, DA Form 10-238, reflects, at any given period, the inventory of packaged petroleum products and empty cans and drums (fig. 11). The inventory is taken at intervals necessary to satisfy requests for information from higher headquarters, and as necessary, to verify and adjust stock records.

h. Petroleum Loading and Discharging Reports.

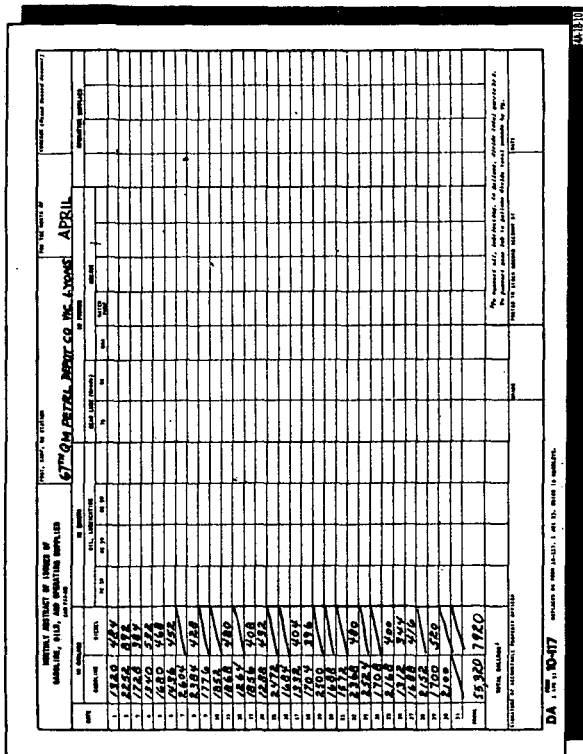
- (1) Records of petroleum loading and discharging of tankers, barges, and/or pipelines are kept on DD Form 250-1 (Tanker/Barge/Pipeline Shipping

PETROLEUM PRODUCTS STORAGE TANK GAGE RECORD (FM 10-37)			DATE	TIME
67TH QM PETRL DEPOT CO			1 APR 59	1630
STATION			TANK DATA	
Vic LYONS			HEIGHT	DIAMETER
TANK NUMBER			5000 661's	CONSTRUCTION
10			5000 661's	<input type="checkbox"/> WELDED <input checked="" type="checkbox"/> POLYESTER
PRODUCT OR GRADE			PARTIALLY FULL	
DIESEL				
LINE	PROCEDURE	EMPTY	OPENING	CLOSING
1	TANK READING		6'8"	0'11 1/8"
2	DOB READING		0'2 1/2"	0'3 1/2"
3	REFERENCE HEIGHT		8'5 1/8"	8'5 1/8"
4	OUTAGE (1 Plus 2)		6'5 1/2"	1'2 3/4"
5	IMAGE (3 Minus 4)		1'11 3/4"	7'2 3/4"
6	WATER SEDIMENT LEVEL		0'3 1/8"	0'3 1/2"
7	CORRECTED IMAGE (3 Minus 6)		1'8 1/4"	6'11 1/2"
8	AVERAGE TEMPERATURE °F		66°F	68°F
9	MULTIPLIER		.9970	.9960
10	TOTAL (U.S. Gallons)		4,696.119	18,906.943
REMARKS (Include sample number)				
SAMPLE # 58-465				
NAME AND GRADE OF OPERATOR (Print or type)			NAME AND GRADE OF GAGER (Print or type)	
Lex B. Jenkins, Sgt.			S.A. Thomas, SP4	
SIGNATURE OF OPERATOR			SIGNATURE OF GAGER	
Lex B. Jenkins			S.A. Thomas	
DA FORM 10-237			E 5419	

Figure 8. Storage tank gage record.

DAILY ISSUES OF GASOLINE AND OILS (TM 38-403)												SHEET 1 OF 3 SHEETS	
POST, CAMP, OR STATION 67 TH QM PETRL DEPOT CO VIC LYONS		ATTENDANT'S SIGNATURE Edward J. Long										DATE 1 APRIL 1959	
VEHICLE IDENTIFICATION NUMBER		IN GALLONS			IN QUARTS			IN POUNDS			ORGANIZATION	SIGNATURE, GRADE, SERVICE NUMBER	
		Gasoline	Diesel	Oil	Oil	Oil	Oil	Oil	Oil	Oil			
		OE NO. 10	OE NO. 30	OE NO. 50	GRADE	75	90	QAA	WATER PUMP	GREASE			
	200			2							133 QM Bn		
	410			3							117 QM Bn		
	150			1							116 QM Bn		
	220										119 QM Bn		
	350			1							120 QM Bn		
TOTAL		1330		7								W. T. Kelly, Sgt.	
DA FORM 1 SEP 53 10-118		EDITION OF 1 DEC 45 MAY BE USED										44-189	

Figure 9. Daily issues of gasoline and oils.



[illegible]

Figure 11. Package area inventory.

report) and DD Form 250-2 Tanker/Barge/Pipeline Discharge Report).

- (2) Tank car or tank truck loadings are usually recorded in a tank car book and a tank truck book.

33. Technical Records and Reports

a. Technical reports of the petroleum depot company normally are prescribed by higher authority. These reports will consist of summaries of production and technical records. The records and reports should cover the—

- (1) Number of sections in operation.
- (2) Number of operating hours for each section.
- (3) Production output.
- (4) List of parts, tools, and equipment critically needed.

b. Some suggested records and reports which may be used by the petroleum depot company are as follows:

- (1) *Vehicle maintenance records.* Maintenance records for vehicles will be kept on DA Form 460 (Preventive Maintenance Roster). Weekly, semimonthly, and monthly records will be completed.
- (2) *Daily preventive maintenance schedule.* Each pump station shift should maintain an Engine Operator Maintenance and Operational Log (DA Form 10-239). The completed forms (fig. 12) should be filed in the pipeline platoon headquarters.

PETROLEUM PRODUCTS ENGINE OPERATOR MAINTENANCE AND OPERATIONAL LOG (PM 10-37)		DATE 20 APR. 59	
NAME AND GRADE OF ENGINE OPERATOR	STATION NUMBER	TIME	
MILTON G. SPAIN, CPL	2	FROM 0700	TO 1500
UNIT NUMBER:			
1. RADIATOR FLUID (Checked and quant added)	<input checked="" type="checkbox"/>	1 qt.	<input checked="" type="checkbox"/>
2. BATTERY WATER (Checked or added)	<input checked="" type="checkbox"/>		Added
3. CRANKCASE OIL (Checked and quant added)	<input checked="" type="checkbox"/>	Added	<input checked="" type="checkbox"/>
4. HEAD TEMPERATURE (Measured or not)	<input checked="" type="checkbox"/>	N	N
5. FUEL SUPPLY AND CONNECTIONS (Check)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6. FUEL CONSUMPTION (Bottom)	39	49	31
7. GENERATOR (Change or discharge)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8. FUEL SEDIMENT OIL (Checked or added)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9. FAN BELT TENSION (Check or adjust)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	A
10. WELD AND FRAME BOLTS (Check or tighten)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11. SHAFT SEAL (Check)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12. ENGINE OIL PRESSURE	60	59	61
13. HOURS OPERATED	Needs OPERATED THIS PERIOD	60	76
14. OTHER (Cumulative)			111
REMARKS: UNITS 1, 3 AND 4 ON LINE AT 0700. GENERATOR ON NUMBER 4 FAILED AT 1400 HOURS. REMOVED UNIT FROM LINE AND PUT UNIT 2 ON LINE. CLEANED COMMUTATOR ON UNIT 4 AND REPLACED UNIT IN SERVICEABLE CONDITION.		PREVENTIVE MAINTENANCE WAS PERFORMED AS INDICATED ABOVE. SIGNATURE AND GRADE OF OPERATOR Milton G. Spain, CPL. UNIT 67 Q.M. PETRODEPOT Co.	

DA FORM 10-239
SEP 57

Figure 12. Engine operator and operational log.

As fuel and oil consumption is a good indication of engine operating efficiency, this form is a check on each engine of a pump station.

- (3) *The 100-hour inspection.* Each pump unit is inspected at intervals of about 100 hours operation to insure necessary adjustments to compensate for normal wear. The 100-hour inspection is the responsibility of unit mechanics or maintenance crews. The 100-Hour Preventive Maintenance Record (DA Form 10-240) should be used. Completed DA Forms 10-240 (fig. 13) may be kept on record within the pipeline section or pipeline platoon headquarters.
- (4) *Operations log.* Each operating shift of a pipeline pump station should maintain

PETROLEUM PRODUCTS 100-HOUR PREVENTIVE MAINTENANCE RECORD (FM 20-27)				
UNIT NUMBER:	I	II	III	IV
LUBRICATION	PERIOD	TECHN	TEAM	WASH
1. CHECK AIR CLEANER, SERVICE, CLEAN OIL		✓		
2. CHANGE OIL - PLAIN GRADES AND		✓		
3. CHANGE FILTER AT RECOMMENDED PERIOD		✓		
4. LUBRICATE ALL LUBRICATION POINTS		✓		
ENGINE	PERIOD	TECHN	TEAM	WASH
5. START ENGINE - RUN TO OPERATING TEMPERATURE		✓		
6. TIGHTEN CYLINDER HEAD BOLTS		✓		
7. TIGHTEN MAINFOLD BOLTS		✓		
8. ADJUST VALVES		✓		
9. CHECK VALVE MECHANISM		✓		
10. CLEAN AND ADJUST SPARK PLUGS		✓		
11. CLEAN CHECK VALVES		✓		
12. CHECK CARBURETOR ADJUSTMENT AND LINKAGE		✓		
13. CHECK FUEL LINES AND FILTERS		✓		
BATTERY	PERIOD	TECHN	TEAM	WASH
14. CHECK, CLEAN, TIGHTEN TERMINALS		✓		
15. TAKE HYDROMETER READING		✓		
16. CHECK HOLD-DOWN BOLTS		✓		
STARTER AND GENERATOR	PERIOD	TECHN	TEAM	WASH
17. CHECK MOUNTING AND PULLEYS		✓		
18. CHECK WIRING AND CONNECTIONS		✓		
19. CHECK ARMATURES AND BRUSHES		✓		
GENERAL	PERIOD	TECHN	TEAM	WASH
20. CHECK FAN BELT		✓		
21. CHECK CLEARANCES OF UNIT		✓		
22. CHECK MOUNTING BOLTS		✓		
23. CHECK MOUNTING OF ACCESSORIES		✓		
PUMP	PERIOD	TECHN	TEAM	WASH
24. CHECK COUPLING ALIGNMENT		✓		
25. CHECK SHAFT SEAL		✓		
26. CHECK LUBRICATION POINTS		✓		
27. CHECK HOLD-DOWN BOLTS		✓		
28. CHECK SHAFT COUPLING		✓		
REMARKS				
DEFECTIVE WATER PUMP CHECK OUT AND REPAIR OR REPLACE				
PUMP SERIAL NUMBER		ENGINE SERIAL NUMBER		
1297219		183247		
SIGNATURE AND GRADE OF INSPECTOR				
Harold E. Bunnins M/sgt.				
DATE				
2 APR 59				

Figure 13. The 100-hour preventive maintenance record.

a pipeline pump station operations log. The operator on each shift will inspect the pumps hourly and make the required entries on the Pump Station Operations Log (DA Form 10-241). At the end of the shift the log (fig. 14) should be turned in to the section chief who may

PETROLEUM PRODUCTS PUMP STATION OPERATIONS LOG													
67TH Q.M. PETROL DEPOT Co										Vic Lyons			
DATE 1 APR 59										STATION 4			
TIME	PUMP NUMBER 1				PUMP NUMBER 2				PUMP NUMBER 3				STATION
	SERIAL NO.	0176256	0183247	0175623	SERIAL NO.	0175623	0175623	0175623	SERIAL NO.	0175623	0175623	0175623	
	SUC TION PRESSURE	DISCHARGE PRESSURE	WATER TEMPERATURE	WATER TEMPERATURE	SUC TION PRESSURE	DISCHARGE PRESSURE	WATER TEMPERATURE	WATER TEMPERATURE	SUC TION PRESSURE	DISCHARGE PRESSURE	WATER TEMPERATURE	WATER TEMPERATURE	
1 0800	20 170	160 40	160 170	320 1800 40 160	—	—	—	—	—	—	—	—	470 530
2 0900	20 170	160 40	160 170	320 1800 40 160	—	—	—	—	—	—	—	—	470 530
3 1000	20 170	160 40	160 170	320 1800 40 160	—	—	—	—	—	—	—	—	470 530
4 1100	20 170	160 40	160 170	320 1800 40 160	—	—	—	—	—	—	—	—	470 530
5 1200	20 170	160 40	160 170	320 1800 40 200	—	—	—	—	—	—	—	—	470 530
6 1300	20 170	160 40	170	—	—	—	—	—	—	—	—	—	470 530
7 1400	20 170	160 40	170	—	—	—	—	—	—	—	—	—	470 530
8 1500	20 170	160 40	170	—	—	—	—	—	—	—	—	—	470 530
9 1600	20 170	160 40	170	—	—	—	—	—	—	—	—	—	470 530
10 1700	20 170	160 40	170	—	—	—	—	—	—	—	—	—	470 530
11 1800	20 170	160 40	160	—	—	—	—	—	—	—	—	—	470 530
12 1900	20 170	160 40	160	—	—	—	—	—	—	—	—	—	470 530
13 2000	20 170	160 40	160	—	—	—	—	—	—	—	—	—	470 530
14 2100	20 170	160 40	160	—	—	—	—	—	—	—	—	—	470 530

DA FORM 10-241

(Continued on Reverse Side)

10-241

[illegible]

Figure 14. Pump station operations log.

in turn forward it to the platoon headquarters.

- (5) *Pipeline leakage report.* Whenever pipeline patrolmen-repairmen discover a leak during patrols, or when they are sent out to find trouble indicated by pump station operations along the pipeline, a Pipeline Leakage Report (DA Form 10-242) should be prepared. This report (fig. 15) will be forwarded through channels to the petroleum depot commander.
- (6) *Status report.* The class III status report is an instrument the petroleum depot company may use to requisition petroleum supplies. It includes information as to stock on hand, receipts, issues, transfers, gains, and losses during a

PETROLEUM PRODUCTS PIPELINE LEAKAGE REPORT (DA Form 10-242)		DATE 17 APR. 59	TIME 1400
TO HQ. 67TH Q.M. PETROL. DEPOT Co.		FROM (Date) 67TH Q.M. PETROL. DEPOT Co.	
REPORTED BY (Name and Grade) Thomas N. Edwards, CPL.		PLATOON AND SECTION 1ST - SEC 2	
LOCATION OF LEAK PUMPING STATION 2	APPARENT CAUSE OF LEAK DURING HIGH WINDS, TREE WAS UPROOTED AND FELL ACROSS PIPELINE		
JOINT NUMBER 19			
FUEL LOST (Gallons) ESTIMATED 1500	DISPOSITION REPLACED DAMAGED SECTION OF PIPE		
PRECAUTIONS TAKEN BLANKETED THE AREA WITH FORM AND DRAINED OFF ISOLATED POOLS			
SIGNATURE AND GRADE OF SECTION CHIEF Christopher C. Jones, M/SGT.		SIGNATURE AND GRADE OF PLATOON LEADER Harvey J. Richardson, 1st LT.	
DA FORM 10-242 1 SEP 57			

44-18-15

Figure 15. Pipeline leakage report.

given period; and requirements for the next period. Reports are submitted in accordance with schedules established by higher headquarters. A suggested sample report is illustrated in figure 16. Columns should be added and/or deleted, as required, to reflect bulk or packaged products, or a combination of both. The form may be locally-reproduced. The provisions of paragraph 20a, AR 310-1 apply.

Figure 16. Class III status report (suggested).

Figure 16. Class III status report (suggested).

CHAPTER 4

ADMINISTRATION

34. General

Administration is the management, guidance, supply, physical conditioning, leadership, discipline, and morale of company personnel. It may be regarded as the means by which the depot commander directs the internal operations of the company. Normally, instructions on company supply, mess, personnel administration, and training will be contained in standing operating procedures.

35. Training

While supervision and guidance may be provided from the headquarters to which the petroleum depot company is attached, the responsibility for training the company rests upon the depot commander. To accomplish training, he is provided with—

a. Army Training Program (ATP) 10-110 which prescribes individual training for personnel of all quartermaster units.

b. ATP 10-377 which provides guidance and scope of instruction for the unit training of the company.

c. Army Training Test (ATT) 10-377 which is given to determine the tactical and technical proficiency of the unit upon completion of the training program.

36. Messing

The company has organic personnel and equipment sufficient to operate a company mess. This permits the company to operate independently and at a distance from other units or installations. The company seldom operates at a single location, however, due to dispersion and the necessity to spread out tank farms, pump stations, and other facilities over a considerable distance. This makes it necessary that the mess be prepared to operate as the situation dictates. Small detachment cooking outfits are provided each pipeline platoon headquarters and pipeline section. Mess personnel may be detached from company headquarters to provide for the subordinate elements. Company mess personnel may be placed on duty in a consolidated mess.

37. Unit Supply

Unit supply includes the requisition, receipt, storage, maintenance, and issue of clothing, arms, ammunition, individual and organizational equipment, fuel, office supplies, and other administrative equipment. It includes also laundry and salvage. Specific procedures and/or schedules for these supplies and services will normally be prescribed by battalion or other command headquarters. Within such instructions, the company commander must develop procedures and schedules applicable to the various elements of the company.

38. Records and Reports

Administration involves the maintenance and submission, as required, of a variety of reports dealing with company personnel and/or company activities. Principal among these are the morning reports; daily sick slip; duty roster; and officer and enlisted qualification records, enlisted service records, and other documents which are part of the personnel records jacket and the financial data records folder for officer and enlisted personnel. To insure proper preparation of personnel records, the company personnel administrative clerk may, if directed, be placed on duty with battalion headquarters and work directly under the supervision of the battalion adjutant or personnel officer.

a. Policy File. While not mandatory, the depot commander should maintain a policy file containing a summary of such decisions, experiences, or other information as he desires to serve as a guide for company personnel. The policies may be in the form of brief notes, plans, or directives and may include current policies of higher headquarters.

b. Standing Operating Procedure. A standing operating procedure (SOP) should be established to expedite operations and to set forth those instructions the company commander desires to make routine. The standing operating procedure should be changed as necessary to meet changing conditions or to effect modifications in existing practices. The amount of detail will depend pri-

marily upon the state of training of the company, but must be sufficiently complete to serve as a guide for new arrivals to the unit. Normally, the battalion or other headquarters to which the company may be attached will provide a standing operating procedure to which the company SOP must conform.

c. Unit Journal and History. The preparation and maintenance of a unit journal and history are normally regarded as command functions. Depending upon specific command or theater army policy, the history may be a monthly or quarterly review of all company activities. The unit journal is normally prepared on a daily basis to give a chronological record of events. Detailed instructions concerning the scope and preparation of unit history are contained in AR 220-345. Information on the daily journal is contained in FM 101-5.

d. Command Report. The depot commander may, in the combat zone, be called upon to provide information for the monthly command report prepared, in accordance with theater army policies and/or SR 525-45-1, by the battalion or other headquarters to which the company is attached.

39. Administrative Procedures

a. Certain administrative procedures must be followed when the assigned mission of the company is an initial operation, relief of another company, or change of commanders. Specific pro-

cedures will vary slightly depending upon the situation and the desires of the command headquarters to which the company is attached. The measures listed below are, however, universally applicable. They are not listed in sequence of priority.

- (1) Determine exact nature and scope of mission to be performed.
- (2) Obtain all available information on units or troops to be supported.
- (3) Determine time operations are to begin.
- (4) Submit to command headquarters a statement of critical shortages of supplies and equipment.
- (5) Prepare, review, and revise standing operating procedures as necessary.
- (6) Arrange for installation of communications network.
- (7) Prepare a security and defense plan.
- (8) When change of commanders is involved, conduct inventory of all company property and equipment; audit council book; accomplish transfer of accountability; and inspect all operating elements of the company.

b. Frequent staff visits and inspections will normally be made by the commander or the members of the command headquarters staff to determine the military and technical efficiency of the company. These inspections may be classified as follows:

- (1) *Command maintenance.* Command maintenance inspections are made to—
 - (a) Insure the adequacy and efficiency of organizational maintenance.
 - (b) Establish the adequacy and use of technical manuals.
 - (c) Determine the adequacy of records, authorized levels of equipment, supply economy practices, and preservation and safekeeping of authorized tools and equipment.
- (2) *Administrative.* Administrative inspections are conducted to determine whether the company is complying with prescribed regulations and directives, command headquarters standing operating procedures, and/or instructions from higher headquarters.
- (3) *Command.* Command inspections cover such activities as food service, sanitation, discipline, and general military effectiveness.
- (4) *Tactical and training.* Tactical and training inspections are used to evaluate training, ascertain readiness of the company for field duty, and correct training deficiencies. Inspections may be formal or informal and are normally made before the unit is committed to actual field operations.

40. Movement

a. Orders and Plans. The petroleum depot company commander will prepare and maintain a current movement plan for the company. Movement orders originate from higher headquarters and are usually preceded by warning orders. After the warning order has been received, the petroleum depot company commander notifies the unit officers so that they can submit specific plans for the movement of their platoons for inclusion in the company plan of movement. To insure prompt compliance with movement orders, plans should include:

- (1) Detailed loading tables for personnel, equipment, and supplies (to include weight and cube).
- (2) Transportation requirements for motor, rail, or air movement.
- (3) Loading and unloading plans for personnel.
- (4) Assignment of responsibilities to officers and noncommissioned officers.
- (5) Clearance of the area upon departure of the company.

b. Responsibilities. Responsibility for successful movement of the company rests with the petroleum depot company commander. He delegates authority to the officers of the company, holding them responsible for the performance of certain duties incident to the movement.

c. Procedures. To obtain transportation for movement by any means, the company commander

will submit a transportation request to the transportation movements office which will coordinate arrangements and provide the appropriate transport.

41. Defense and Security

The petroleum depot company must be prepared to defend itself against air, ground, and nuclear, biological, and chemical attack. The company commander should prepare a defense plan that will fit into the defense plan prescribed by higher headquarters and one that can be coordinated with the defense plan of adjacent units. The general plan for defense of the company should establish both active and passive defense measures.

a. Active Defense Measures. The defense plan should be clear and brief so as to be easily understood. As the company may be subjected to numerous types of attack, flexibility of the plan is an essential factor. Company personnel should be well trained in the use of organic weapons and assigned definite defensive positions in the event of enemy attack.

b. Passive Defense Measures. Passive measures are taken to reduce casualties and damage in the event of attack and to prevent enemy observation of the operating elements of the company. Dispersion, cover, and camouflage of supplies, equipment, and personnel will reduce casualties and damage from artillery fire and from nuclear, biological, and chemical weapons. Training in de-

fense measures against such attack should be stressed to enable company personnel to survive such attacks and to minimize interruption of pipeline and terminal operations.

- (1) In the event of enemy attack with nuclear, biological, or chemical weapons, company personnel should be able to—
 - (a) Perform their mission during friendly or enemy employment of such weapons.
 - (b) Perform simple decontamination of the person, personal equipment, and unit equipment and materiel.
 - (c) Perform first aid for casualties from nuclear, biological, and chemical agents.
 - (d) Recognize standard marking signs indicating areas contaminated with such agents.
 - (e) Cross or bypass radiological, biological, or chemical contaminated areas with minimum danger to themselves.
 - (f) Maintain individual protective equipment.
 - (g) Maintain a high order of health, personal hygiene, and sanitary discipline as a protective measure against biological warfare.
 - (h) Take protective measures against the blast, heat, and radiation effects of nuclear explosions.

- (i) Operate chemical agent detector kits and various radiation detection instruments organic to the company.
- (2) The most destructive effects of such attack on petroleum terminals and pipelines are the blast and thermal effects of a nuclear explosion. The blast effect can cause severe damage to petroleum storage tanks, pipelines, and cans and drums. The thermal activity that follows a nuclear explosion can ignite leaking storage facilities and pipelines. Protection against nuclear weapons is best afforded by—
 - (a) Providing alternate petroleum storage areas, each containing a complete line of petroleum products.
 - (b) Placing pipeline underground where possible.
 - (c) Maximum utilization of natural cover and camouflage for pipelines and terminals.
 - (d) Use of revetments and underground storage areas where possible.
 - (e) Dispersion of packaged petroleum storage areas.
 - (f) Elimination of litter and combustible materials in and around terminals and storage areas.
 - (g) Use of dummy terminals, pipelines, pump stations, and storage areas.

42. Demolition

Demolition of petroleum depot facilities is a command responsibility and will usually be done on orders from higher headquarters. In extreme emergencies, however, the petroleum depot company commander must be prepared to take the initiative to prevent any petroleum depot materiel and supplies from falling into the hands of the enemy. Demolition methods must be adequate, uniform, easy to follow, and flexible enough to permit on-the-spot changes. Destruction must be as complete as possible, and adequate safety precautions must be taken to protect demolition personnel.

a. Terminals and Pipelines. Storage tanks can be pumped out, made to overflow by pumping in water, or ignited by fire or explosive. Pumps, engines, and other equipment contained in pump stations and terminal manifolds should be dismantled, smashed, and set afire with gasoline. The demolition of petroleum products may also be coordinated with tactical plans to destroy or contaminate resources and facilities which might be of benefit to the enemy.

b. Canning and Storage Areas. Products packaged in cans and drums should be destroyed by fire. Grease, oils, and heavy lubricants do not burn easily, but burning can be speeded by puncturing containers and saturating them with gasoline. The gasoline trails to be ignited should always be laid a safe distance from the material to be destroyed. Vehicles, gasoline dispensers,

and drum cleaners should be dismantled, smashed, and burned.

43. Fire Precautions

Due to the flammable nature of petroleum fuels, fire precautions are most important safety considerations in the operation of petroleum pipelines and terminals. Personnel of the petroleum depot company should be instructed and reminded of the hazards of petroleum operations, and operating personnel should exercise every possible precaution at all times. The following fire precautions should always be observed in petroleum handling areas.

a. All equipment, such as pumps, tanks, vehicles, or storage tanks, must be electrostatically bonded and grounded when used in transfer operations. Bonding connection must be made before hose connections and should not be removed until hose has been disconnected.

b. Open flames, heating stoves, electrical tools, and other flame or spark-generating equipment must be kept away from the operating area.

c. Only authorized items of clothing, explosion-proof lights, tools, equipment should be used.

d. Precautions should be taken against sparks from equipment exhaust systems, nearby railroad trains, shoes with metal nails, metal buttons, and from striking metal against metal.

e. Under no circumstances will gasoline be used for cleaning floors or clothes or for kindling fires.

f. No filtering of gasoline under pressure should be allowed. The use of a chamois skin over the end of a nozzle to act as a strainer or filter should be prohibited as it is a source of static electricity.

g. Gasoline spills should be avoided and cleaned up immediately when they occur. If an absorbent agent is needed, sand should be used.

h. All containers, hose connections, faucets, and similar equipment should be inspected frequently for leaks.

i. Fire-fighting troops should accompany repair crews on line-break assignments as each break must be regarded as a potential fire.

j. Rules prohibiting smoking must be established and strictly enforced. Adequate NO SMOKING signs must be prominently posted, and carrying matches and cigarette lighters must be forbidden.

k. All personnel coming into contact with petroleum products in the course of their normally assigned duties should be thoroughly trained in the proper use and maintenance of all fire-extinguishing equipment.

l. Fire extinguishers and other fire-fighting equipment must be in working condition, easily accessible, available in the type and number required, and conspicuously marked.

44. Safety Measures

Safety is an important consideration in the handling of petroleum products. Petroleum depot personnel engaged in pipeline and terminal opera-

tions must be constantly on guard to prevent accidents to personnel and damage or loss of property and equipment. The following safety precautions should always be observed in petroleum-handling areas:

a. Handling Gasoline.

- (1) Avoid excessive inhalation of gasoline vapors. These vapors have a toxic effect on man, and excessive inhalation may cause unconsciousness. First aid should be given, and medical attention should be secured as soon as possible.
- (2) Operating personnel exposed for prolonged periods to leaded gasoline may develop lead poisoning. To limit the period of individual exposure to lead-treated gasoline vapors, personnel should be rotated on the job.
- (3) When gasoline is accidentally swallowed, vomiting should be induced and medical attention secured as soon as possible.
- (4) If gasoline is spilled on clothing, the wearer should immediately remove clothing and allow gasoline to evaporate.
- (5) When gasoline comes in contact with the skin, it should be washed off immediately with soap and water.
- (6) If gasoline comes in contact with the eyes, olive oil, castor oil, mineral oil, or vaseline should be applied immediately and medical attention secured as soon as possible.

b. Handling Diesel Fuel, Kerosene, and Jet Fuels.

- (1) These products should not be inhaled for an extended period.
- (2) While not as irritating as gasoline, they should be washed off immediately when they come in contact with the skin.
- (3) When any of these fuels come in contact with the eye, action should be taken as with gasoline.

c. Storage of Petroleum Fuels.

- (1) Transfer operations should be closely watched to prevent overflow or to stop the flow in case of emergencies.
- (2) Storage containers should allow space for probable expansion of petroleum product.
- (3) When cleaning or inspecting tanks, vessels, or other storage facilities with a high concentration of gaseous vapors, a blower-type fresh air mask should be worn.

CHAPTER 5

COMMUNICATIONS

45. General

The communications system of the company provides the necessary flexibility to cope with changing tactical situations and logistical requirements. It is based on the building-block principle and contemplates a system dispatcher charged with control over the movement of all petroleum shipments in the pipeline system. Under such an arrangement, the petroleum officer in the depot control section (par. 11) acts as a district dispatcher and issues dispatching instructions to the pipelines, pump stations, and tank farms operated by the company. Under certain circumstances, the functions of the system dispatcher and the petroleum officer of the company may be accomplished at the same location. This is particularly true if the company is operating the terminal at which product is first received. Such a concept allows the communications network to be kept relatively simple to preserve quality of transmission, permit maximum alternate routing, and facilitate troubleshooting and restoration of service. In practice, the company employs teletypewriter, radio, and telephone circuits. The complete communications system is schematically depicted in figure 17.

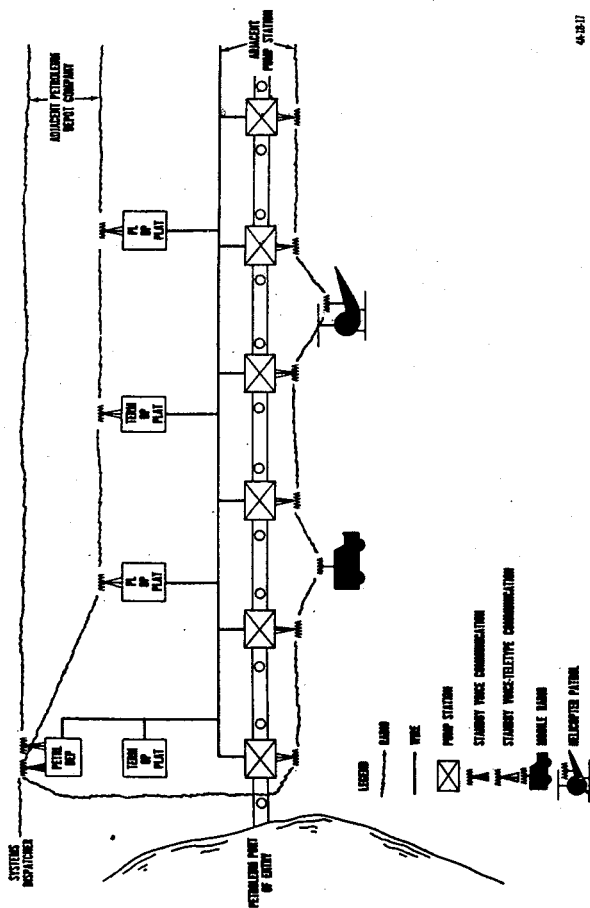


Figure 17. Quartermaster petroleum depot company communications system.

46. Teletypewriter Communications

a. Teletypewriter is the primary means of communication for the control of the pipeline. The system dispatcher normally has a teletypewriter circuit to each of the petroleum depot companies in the pipeline system. These circuits are provided by telegraph carrier equipment on the radio relay system. The systems dispatcher is provided in addition, a teletypewriter switchboard and teletypewriter capable of transmitting messages by tape. These circuits extend to the petroleum depot companies which are equipped with teletypewriters capable of receiving both tape and page copy. Principal among these are the—

- (1) *Teletypewriter set TT-4/TG*. This is a portable standard communications page printing teletypewriter designed to transmit, monitor, and receive messages under field conditions. These sets are provided to the depot control section, pipeline platoon headquarters, terminal operating platoon headquarters, and each pipeline section. Operating and maintenance procedures are set forth in TM 11-2234.
- (2) *Teletypewriter set AN/GGC-3*. This is a lightweight transportable unit which may be used in either fixed or tactical military teletypewriter stations. They provide manual transmission directly from keyboard and for tape transmis-

sion. Received messages are printed and perforated on a paper tape for later transmission. These sets are located in the depot control section and pipeline platoon headquarters. Operating and maintenance procedures are set forth in TM 11-2225.

- (3) *Radio teletypewriter set AN/GRC-46.* This set provides back-up support for teletypewriter and voice circuits. It is used by the company as a fixed-portable station capable of providing voice transmission up to 35 miles or teletypewriter transmission up to 75 miles. These transmission distances are approximate, as the operating distance between two stations is variable and depends upon such factors as site selection, type antenna used and frequency utilized. The set is located in the depot control section. Operating and maintenance procedures are set forth in TM 11-5815-204-10.

b. Use of the switchboard enables the system dispatcher to contact one or all of the petroleum depot companies along the pipeline either separately or in any combination desired. This arrangement further allows any petroleum depot company to contact any adjacent petroleum depot company for administrative purposes.

c. The teletypewriter circuitry also permits the petroleum officer access to each of the pump stations on a party line basis. For this purpose, each

of the pump stations is equipped with a page printing teletypewriter.

47. Radio Communication

a. A radio voice circuit provides two-way communications between pump stations and mobile land and air patrols as well as standby communications among pump stations. A voice circuit provides back-up communications for the systems dispatcher to the petroleum depot company. This circuit is provided over the same high-frequency radio facilities as the back-up teletypewriter circuit. It is used to back up the direct teletypewriter circuits provided by carrier and is operated on a net operations basis.

b. To provide for radio communications, the company is equipped with—

- (1) *Radio set AN/FRC-27.* This set is used primarily as a fixed station and requires very little attention by operating personnel. The set is designed for voice transmission and reception by frequency modulated (FM) signals. It is designed to net with AN/VRC-19 and the AN/PRC-21 radio sets organic to the company. The distance range of the set is line of sight. These sets are located in the control section, terminal operating platoon headquarters, and pipeline sections. Operating and maintenance procedures are set forth in TM 11-226.
- (2) *Radio set AN/VRC-19.* This set is a

mobile, frequency modulated (FM) set normally used for nontactical purposes with an operating range of approximately 25 miles. This set is mounted in a $\frac{3}{4}$ -ton truck and is used by pipeline maintenance personnel and pipeline patrols. The set nets with radio set AN/FRC-27 used in pipeline pump stations and radio set AN/PRC-21 used by pipeline patrolmen and tank farm attendants. It is located in pipeline platoon headquarters and pipeline sections. Operating and maintenance procedures are set forth in TM 11-297.

- (3) *Radio set AN/PRC-21.* This is a small portable voice (FM) radio designed to be carried by hand or by means of a shoulder carrying strap. It can be used in connection with the vehicular mounted radio set AN/VRC-19 to extend the use of two-way radio telephone communications to areas inaccessible to vehicles. It is specially designed to aid in performing functions such as pipeline patrolling, inspection and maintenance, tank farm operations, and similar services. It is located in the depot control section, pipeline platoon headquarters, terminal operating platoon storage sections, and pipeline sections. Operating and maintenance procedures are set forth in TM 11-610.

- (4) *Radio teletypewriter set AN/GRC-46.*
See paragraph 46a(3).

48. Telephone Communications

a. The telephonic circuitry may be divided into the following elements:

- (1) The circuit between the systems dispatcher and the petroleum depot company. This circuit allows communications between systems dispatcher and the first and second petroleum depot company along the pipeline system.
- (2) The circuit between the petroleum depot company and its pump stations. This circuit provides communications on a party line basis. Manual code ringing is employed.
- (3) The company circuit which is used by company elements for administration and operational purposes. All company elements are included in one or more of the telephone circuits.

b. The telephone sets used by the company are the TA-264/PT and the TA-312/PT telephones. The TA-264/PT telephones are used for the party line circuit. The TA-312/PT telephones are generally used in the circuits not connected to the party line. Operating and maintenance procedures for these telephone sets are contained in TM 11-2059 and TM 11-2155.

APPENDIX I

REFERENCES

AR 220-70	Companies—General Provisions
AR 220-345	Unit Histories
AR 220-346	Journals and Journal Files
AR 310-3	Military Publications—Preparation and Processing
AR 320-5	Dictionary of United States Army Terms
AR 320-50	Authorized Abbreviations and Brevity Codes.
AR 345-250	Maintenance and Disposition of Management Files
AR 525-24	Command Report
AR 611-201	Manual of Enlisted Military Occupational Specialties.
AR 700-5	Organization & Operation of Inventory Control points
AR 700-9100-3	Quality Surveillance and Test Facilities for Petroleum Products in Oversea Areas
AR 701-9100-1	Petroleum Supply System
AR 711-16	Installation Stock Control and Supply Procedures
SR 605-105-5	Commissioned and Warrant Officer Personnel Military Occupational Specialties
SR 890-45-1	Estimated Requirements for Petroleum Products

DA Pam 108-1	Index of Army Motion Pictures, Film Strips, Slides, and Phono- Recordings
DA Pam 310-1	Index of Administrative Publi- cations
DA Pam 310-2	Index of Blank Forms
DA Pam 310-3	Index of Training Publications
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders and Modification Work Orders.
DA Pam 310-7	Index of Tables of Organization and Equipment, Tables of Organization, Type Tables of Distribution, and Tables of Allowances
DA Pam 310-30	Index of Supply Manuals— Quartermaster Corps
JCS Pub. 1	Dictionary of United States Military Terms for Joint Usage
FM 5-20	Camouflage, Basic Principles and Field Camouflage
FM 5-25	Explosives and Demolitions
FM 10-6	Quartermaster Service Company
FM 10-13	Quartermaster Reference Data
FM 11-17	Tactical Communications Center Operation
FM 20-15	Tents and Tent Pitching
FM 21-5	Military Training
FM 21-6	Techniques of Military Instruc- tion

FM 21-10	Military Sanitation
FM 21-30	Military Symbols
FM 21-40	Small Unit Procedures in Atomic, Biological, and Chemical Warfare
FM 21-75	Combat Training of the Indi- vidual Soldier and Patrolling
FM 31-15	Operations Against Airborne Attack, Guerilla Action, and Infiltration
FM 31-25	Desert Operations
FM 31-70	Basic Arctic Manual
FM 31-71	Northern Operations
FM 100-5	Field Service Regulations: Operations
FM 100-10	Field Service Regulations: Administration
FM 101-5	Staff Officers' Field Manual: Staff Organization and Procedures
FM 101-10	Staff Officers' Field Manual: Organization, Technical, and Logistical Data
TM 3-220	Decontamination
TM 5-350	Military Pipeline Systems
TM 10-1101	Petroleum-Handling Operations
TM 10-1103	Quartermaster Petroleum- Handling Equipment
TM 10-1105	Testing Petroleum Products
TM 10-1109	Military Petroleum Pipeline System Maintenance (Quarter- master Corps)
TM 10-1110	Military Petroleum Pipeline System—Terminals

TM 10-1111	Military Petroleum Pipeline System—Pump Stations
TM 10-1112	Military Petroleum Pipeline System—Scheduling and Dispatching
TM 10-1114	Cleaning Bulk Petroleum Storage Tanks, Railway Tank Cars, and Tank Trucks
TM 10-1115	Pump, Centrifugal, Gasoline-Dispensing, Portable, Gasoline-Engine-Driven, Capacity 225-GPM—50-Foot Head
TM 10-1125	Pump, Centrifugal, Gasoline-Dispensing, Portable, Gasoline-Engine-Driven, Capacity 50-GPM—100-Foot Head
TM 10-1130	Tank, Liquid Fuel, Collapsible 900- and 3,000-Gallon
TM 10-1140	Cleaning Machine, Fuel Cans and Drum
TM 10-1158	Petroleum Testing Kit
TM 11-226	Radio Sets AN/FRC-27 and AN/TRC-34
TM 11-297	Radio Set AN/VRC-19, -19X, and -19Y
TM 11-610	Operation and Organizational Maintenance Radio Set AN/PRC-21
TM 11-2059	Telephone TP-9 and Telephone Set TA-264/PT
TM 11-2155	Telephone Set TA-312/PT

TM 11-2225	Teletypewriter Sets AN/GGC-3 and AN/GGC-3A and Teletypewriter Reperforator-Transmitters TT-76/GGC, TT-76A/GGC, and TT-76B/GGC
TM 11-2234	Teletypewriter Sets AN/PGC-1 and AN/TGC-7A, and Teletypewriters TT-4/TG, TT-4A/TG, and TT-173A/TG
TM 11-5815-204-10	Operator's Manual: Radio Teletypewriter Sets AN/GRC-46 and AN/VRC-29
TM 743-200	Storage and Materials Handling
TM 743-200-1	Storage and Materials Handling
ATP 10-110	Advanced Individual Training of Quartermaster Personnel
ATP 10-377	Army Training Program for Quartermaster Petroleum Depot Company
ATT 10-377	Training Test for Quartermaster Petroleum Depot Company Manual for Courts Martial, United States, 1951.

APPENDIX II

TEMPERATURE CONVERSION EQUATIONS AND TABLE

1. Equations for Converting Temperatures

The following equations are used for the conversion of Fahrenheit and Centigrade temperatures. F. = Fahrenheit; C. = Centigrade:

a. Centigrade temperature to Fahrenheit temperature.

(1) *Equation.* $F. = \frac{9}{5} (C.) + 32.$

(2) *Illustration.* Determine the temperature in Fahrenheit degrees where the temperature reading is 10° C.

$$\begin{aligned} F. &= \frac{9}{5} (10) + 32 \\ &= \frac{90}{5} + 32 \\ &= 18 + 32 \\ &= 50^{\circ} \text{ F.} \end{aligned}$$

b. Fahrenheit temperature to Centigrade temperature.

(1) *Equation.* $C. = \frac{5}{9} (F. - 32).$

(2) *Illustration.* Determine the temperature in Centigrade degrees where the temperature reading is 50° F.

$$\begin{aligned} C. &= \frac{5}{9} (50 - 32) \\ &= \frac{5}{9} (18) \\ &= \frac{90}{9} \\ &= 10^{\circ} \text{ C.} \end{aligned}$$

2. Temperature Conversion Table

The following temperature conversion table may be used to convert the degrees of Fahrenheit and Centigrade temperatures from one to the other.

Temperature Conversion Table

C.	F.	C.	F.	C.	F.
-17.8	0	-1.67	29	14.4	58
-17.2	1	-1.11	30	15.0	59
-16.7	2	-.56	31	15.6	60
-16.1	3	0	32	16.1	61
-15.6	4	.56	33	16.7	62
-15.0	5	1.11	34	17.2	63
-14.4	6	1.67	35	17.8	64
-13.9	7	2.22	36	18.3	65
-13.3	8	2.78	37	18.9	66
-12.8	9	3.33	38	19.4	67
-12.2	10	3.89	39	20.0	68
-11.7	11	4.44	40	20.6	69
-11.1	12	5.00	41	21.1	70
-10.6	13	5.56	42	21.7	71
-10.0	14	6.11	43	22.2	72
-9.44	15	6.67	44	22.8	73
-8.89	16	7.22	45	23.3	74
-8.33	17	7.78	46	23.9	75
-7.78	18	8.33	47	24.4	76
-7.22	19	8.89	48	25.0	77
-6.67	20	9.44	49	25.6	78
-6.11	21	10.0	50	26.1	79
-5.56	22	10.6	51	26.7	80
-5.00	23	11.1	52	27.2	81
-4.44	24	11.7	53	27.8	82
-3.89	25	12.2	54	28.3	83
-3.33	26	12.8	55	28.9	84
-2.87	27	13.3	56	29.4	85
-2.22	28	13.9	57	30.0	86

Temperature Conversion Table—Continued

C.	F.	C.	F	C.	F
30.6	87	60	140	149	300
31.1	88	66	150	154	310
31.7	89	71	160	160	320
32.2	90	77	170	166	330
32.8	91	82	180	171	340
33.3	92	88	190	177	350
33.9	93	93	200	182	360
34.4	94	99	210	188	370
35.0	95	100	212	193	380
35.6	96	104	220	199	390
36.1	97	110	230	204	400
36.7	98	116	240	210	410
37.2	99	121	250	216	420
37.8	100	127	260	221	430
43	110	132	270	227	440
49	120	138	280	232	450
54	130	143	290	238	460

APPENDIX III

TANK VOLUME FORMULAS AND TABLES

1. Volume Formulas

a. Cylindrical Tanks.

(1) Formula.

$$v = \pi \frac{d^2}{4} \times h$$

where: v = volume of the tank in cubic feet,

$$\pi = 3.14$$

d = inside diameter of the tank (in feet), and

h = inside height of the tank (in feet).

(2) *Illustrative problem.* Find the capacity of a cylindrical tank 8 feet high with an inside diameter of 21.50 feet. Assume 0.178 barrel per cubic foot.

$$\begin{aligned} v &= 3.14 \times \frac{(21.50)^2}{4} \times 8 \\ &= 2,903 \text{ cubic feet} \end{aligned}$$

Tank capacity = 517 barrels ($2,903 \times 0.178$)

b. Spherical Tanks.

(1) Formula.

$$v = 4.189r^3$$

where: v = volume

r = radius of the sphere,

and $4.189 = \frac{4}{3} \pi$

- (2) *Illustrative problem.* Find the capacity of a spherical tank with a radius of 9 feet. Assume 0.178 barrel per cubic foot.

$$\begin{aligned}v &= 4.189 \times (9)^3 \\&= 3,054 \text{ cubic feet}\end{aligned}$$

Tank capacity = 544 barrels ($3,054 \times 0.178$)

c. Oblate Spheroid Tanks.

- (1) *Formula.*

$$v = 4.189a^2b$$

where: v = volume of the tank,
 a = major semiaxis of the tank, and
 b = minor semiaxis of the tank.

- (2) *Illustrative problem.* Find the capacity of a tank which is an oblate spheroid 20 feet wide and 10 feet high. Assume 0.178 barrel per cubic foot.

The major semiaxis, $a = \frac{1}{2}$ width (20 ft.) = 10 feet

The minor semiaxis, $b = \frac{1}{2}$ height (10 ft.) = 5 feet

$$\begin{aligned}v &= 4.189 \times (10)^2 \\&\quad \times 5 \\&= 2,094.5 \text{ cubic feet}\end{aligned}$$

Tank capacity = 373 barrels
 $(2,094.5 \times 0.178).$

d. Tank-Gaging Formulas (Tank Strapping).

- (1) *General.* It is necessary to know how much fuel any cylindrical storage tank

contains at any time and at any liquid level. Gage tables should be made to calculate the volume in barrels per $\frac{1}{8}$ -inch at $\frac{1}{8}$ -inch intervals from the bottom to the top of the tank. Gagers and dispatchers are furnished with these tables for each tank in the tank farm.

- (2) *Formulas.* The volume of a cylindrical tank is equal to $\pi r^2 h$, where r is the radius of the tank and h is the height. For cylindrical tanks, the following formulas may be used:

$$C^2 \times 0.0011804 = \text{Barrels per inch depth}$$

$$C^2 \times 0.0001475 = \text{Barrels per } \frac{1}{8}\text{-inch depth}$$

$$C^2 \times 0.0002951 = \text{Barrels per } \frac{1}{4}\text{-inch depth}$$

$$D^2 \times 0.011650 = \text{Barrels per inch depth}$$

where: C —the inner circumference of the tank,
and

D —the inner diameter, in feet.

e. Horizontal Cylindrical Tanks.

- (1) *Full tank.* The contents of a full horizontal cylindrical tank is calculated with the formula given in *a* above (simply assuming that the tank is standing on end).
- (2) *Partly full tank.* The contents of a partly full horizontal cylindrical tank with flat ends may be determined by using the table in paragraph 2, below. First, the diameter and length of the tank are measured in feet. Second, the depth of

the liquid from the tank bottom (innage) is measured in feet. With the diameter and innage known, find the corresponding factor on the table. This factor represents the volume of liquid for 1 foot of length of tank. Third, multiply this factor by the length of the tank to obtain the volume in U. S. gallons.

f. Standard Military Fuel Storage Tanks. The table in paragraph 3, below, gives the capacities of standard military fuel storage tanks. The table in paragraph 4, below, gives the deadwood volume which must be subtracted from the computed volume of standard military bolted tanks to give true volume.

2. Volumes of Partially Filled Horizontal Cylindrical Tanks Table

The contents of a partially filled horizontal cylindrical tank can be ascertained by the use of the table facing this page.

3. Standard Military Bolted-Tank Gage Data Table

The gage data table gives the capacities of standard military fuel storage tank.

Standard Military Bolted-Tank Gage Data¹

Depth	L-100 bbl. ²	L-250 bbl. ²	L-500 bbl. ²	H-3,000 bbl. ³ or L-1,000 bbl. ²	H-10,000 bbl. ³
1/4"	0.24	0.69	1.35	2.57	8.81
1/2"	.49	1.38	2.70	5.15	17.62
3/4"	.73	2.07	4.06	7.72	26.43
1"	.98	2.76	5.41	10.30	35.23
2"	1.97	5.52	10.82	20.59	70.47
3"	2.96	8.28	16.23	30.89	105.70
4"	3.95	11.04	21.64	41.18	140.94
5"	4.94	13.80	27.05	51.48	176.17
6"	5.93	16.56	32.46	61.77	211.41
7"	6.92	19.32	37.87	72.07	246.64
8"	7.91	22.07	43.28	82.36	281.88
9"	8.90	24.83	48.68	92.66	317.11
10"	9.89	27.59	54.09	102.96	352.35
11"	10.88	30.35	59.50	113.25	387.58
1'0"	11.87	33.11	64.91	123.56	422.82
2'0"	23.76	66.22	129.83	247.09	845.64
3'0"	35.66	99.34	194.74	370.64	1,268.46
4'0"	47.54	132.45	259.65	494.19	1,691.28
5'0"	59.43	165.56	324.56	617.74	2,114.09
6'0"	71.32	198.67	389.48	741.28	2,536.91
7'0"	83.21	231.79	454.39	864.38	2,959.73
8'0"	95.10	264.90	519.30	988.38	3,382.55
9'0"	106.99	298.01	584.22	1,111.93	3,805.37
10'0"	118.88	331.12	649.13	1,235.47	4,228.19
11'0"	130.77	364.24	714.04	1,359.02	4,651.01
12'0"	142.66	397.35	778.96	1,482.57	5,073.83
13'0"	154.55	430.46	843.87	1,606.12	5,496.64
14'0"	166.44	463.57	908.78	1,729.66	5,919.46

For explanation of footnotes, see notes at end of table.

Standard Military Bolted-Tank Gage Data¹—Continued

Depth	L-100 bbl. ²	L-250 bbl. ²	L-500 bbl. ²	H-3,000 bbl. ² or L-1,000 bbl. ²	H-10,000 bbl. ²
15'0"	178.33	496.69	973.69	1,853.29	6,342.28
16'0"	190.22	529.80	1,038.61	1,976.76	6,765.10
17'0"	-----	-----	-----	2,100.30	7,187.92
18'0"	-----	-----	-----	2,223.85	7,610.74
19'0"	-----	-----	-----	2,347.40	8,033.56
20'0"	-----	-----	-----	2,470.95	8,456.38
21'0"	-----	-----	-----	2,594.49	8,879.19
22'0"	-----	-----	-----	2,718.04	9,302.01
23'0"	-----	-----	-----	2,841.59	9,724.83
24'0"	-----	-----	-----	2,965.13	10,147.65

¹ Capacities are given in standard 42-gallon barrels.

² 1-ring tank.

³ More than 1-ring tank.

⁴ Capacities greater than nominal size are produced by adding an additional ring. No more than one additional ring is permitted.

4. Deadwood for Standard Military Bolted Tanks Table

The deadwood table is used to compute the true volume for standard military bolted tanks.

Deadwood for Standard Military Bolted Tanks¹

Depth	L-100 bbl. ²	L-250 bbl. ²	L-500 bbl. ²	H-3,000 bbl. ² or L-1,000 bbl. ²	H-10,000 bbl. ²
1'0"	0.007	0.008	0.010	0.030	0.055
2'0"	.013	.016	.020	.060	.110
3'0"	.019	.024	.030	.089	.164
4'0"	.026	.032	.040	.119	.217
5'0"	.031	.039	.048	.145	.279

For explanation of footnotes, see notes at end of table.

Deadwood for Standard Military Bolted Tanks¹—Continued

Depth	L-100 bbl. ²	L 250 LLL. ²	L 500 bbl. ²	H-3,000 bbl. ² or L-1,000 bbl. ²	H-10,000 bbl. ²
6'0"	.036	.046	.057	.169	.340
7'0"	.042	.053	.065	.195	.405
8'0"	.047	.058	.073	.219	.467
9'0"	.052	.066	.081	.243	.508
10'0"	.058	.073	.089	.268	.548
11'0"	.063	.079	.098	.292	.586
12'0"	.069	.086	.105	.317	.624
13'0"	.074	.093	.113	.340	.665
14'0"	.079	.100	.122	.366	.700
15'0"	.084	.106	.129	.390	.740
16'0"	.090	.113	.137	.416	.779
17'0"	-----	-----	-----	.441	.817
18'0"	-----	-----	-----	.464	.855
19'0"	-----	-----	-----	.490	.893
20'0"	-----	-----	-----	.521	.933
21'0"	-----	-----	-----	.538	.972
22'0"	-----	-----	-----	.562	1.006
23'0"	-----	-----	-----	.586	1.100
24'0"	-----	-----	-----	.690	1.368

¹ The deadwood figures given above make allowances for bolt-heads, bolt channels, and deck-supporting members. Capacities are expressed in standard 42-gallon barrels.

² 1-ring tank.

³ More than 1-ring tank.

APPENDIX IV

CAPACITIES OF PIPELINES

1. Equation for Determining Capacity

The capacity per mile of any pipeline can be computed with the following equation, in which V equals the volume expressed in 42-gallon, U. S. barrels per mile; d equals the inside diameter of the pipe in inches; and 5.13 is the conversion factor:

$$V = d^2(5.13).$$

2. Table of Pipeline Capacities

The table below may be used to find the capacity of standard military lightweight steel tubing.

Design Capacity of Standard Military Lightweight Steel Tubing¹

	Size of line		Normal design capacity			Emergency capacity			Safe working pressure	Maximum working pressure
	Outside dia. (in.)	Inside dia. (in.)	Barrels per hour	Velocity (ft/sec)	Average station spacing ² (miles)	Barrels per hour	Velocity (ft/sec)	Average station spacing ² (miles)	Pounds per sq. in. (psi)	Pounds per sq. in. (psi)
1	4.000	3.844	285	5.7	6.5	322	6.5	6.5	600	750
2	4.500	4.344	355	5.5	7.9	393	6.1	7.9	600	750
3	6.000	5.780	715	6.0	12.1	900	7.5	12.1	600	750
4	6.625	6.407	785	5.4	16.6	1,000	6.8	16.6	600	750
5	8.000	7.780	1,285	6.6	12.5	1,640	7.5	12.5	450	600
6	8.625	8.407	1,355	5.6	16.6	1,730	6.7	16.6	450	600
7	12.000	11.719	5,720	11.5	1.2	8,580	17.0	.7	300	560
8	12.750	12.469	7,150	12.5	1.1	11,400	20.0	.5	300	530

¹ Design fuel is 0.725 specific gravity fuel. Limit of flow velocity for normal design capacity is approximately 6.5 feet per second for pumping stations and 12.5 feet per second for booster pumping stations.

² Station spacing on level terrain.

APPENDIX V

CAPACITIES OF STANDARD PIPELINE PUMP STATIONS *

The table below may be used to determine the capacity of a standard pipeline pump station for the specified inside diameter of pipeline and type pump units.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Size of pipe		Pump units per station		Normal capacity						Emergency capacity					
Outside diameter (in.)	Inside diameter (in.)	Number	Type	Number of pumps operating	Net available head (ft)	Net available pressure (psi)	Barrels per hour	Barrels per day (24-hr. operation)	Engine speed (rpm)	Number of pumps operating	Net available head (ft)	Net available pressure (psi)	Barrels per hour	Barrels per day (24-hr. operation)	Engine speed (rpm)

TRUNKLINE STATIONS

1	4.500	4.314	2	4-inch, 4-stage.	21,100	336	355	8,520	1,800	21,356	414	393	9,432	2,000
---	-------	-------	---	------------------	--------	-----	-----	-------	-------	--------	-----	-----	-------	-------

2--	6.625	6.407	4	4-inch, 4-stage.	31,395	427	785	18,840	1,800	42,080	700	1,000	24,000	2,000	
3--	8.625	8.407	4	6-inch, 2-stage.	3	996	305	1,355	32,520	1,850	41,520	477	1,730	41,520	2,100

BOOSTER STATIONS

4--	8.625	8.407	2	6-inch, 2-stage.	2	320	98	2,860	68,640	1,850	2	364	111	3,570	85,680	2,100
5--	12.000	11.719	4	6-inch, 2-stage.	4	212	65	5,720	137,280	1,850	4	258	79	8,580	205,920	2,100
6--	12.750	12.469	4	6-inch, 2-stage.	4	205	63	7,150	171,600	1,850	4	225	68	11,400	273,600	2,100

* Based on fuel of 0.725 specific gravity and normal operating conditions.

APPENDIX VI

VOLUME CORRECTION FOR PETROLEUM PRODUCTS

1. Determining API Gravity Number

To convert a measured volume of product at observed temperature to corresponding volume at 60° F., it is first necessary to determine the API gravity group number corresponding to the product by the use of the following table.

API Gravity Groups

Group No.	Coefficient of expansion	Corresponding degrees API	Range of group (degrees API/60°)	Products normally in group
0	.00035	6	Up to 14.9	Heavy crude oils
1	.0004	22	15.0 to 34.9	Light crude oils Residual fuel oils Lubricating oils
2	.0005	44	35.0 to 50.9	Kerosene Heavy diesel fuels Solvents Jet fuels
3	.0006	58	51.0 to 63.9	Motor gasolines Light diesel fuels
4	.0007	72	64.0 to 78.9	Aviation gasolines
5	.0008	86	79.0 to 88.9	} Liquefied gases
6	.00085	91	89.0 to 93.9	
7	.0009	97	94.0 to 99.9	

2. Using Conversion Factors for Various API Groups at Observed Temperatures

The following table gives conversion factors for the various API groups at observed temperatures. Multiply the volume at observed temperature by the appropriate conversion factor to obtain corresponding volume at 60° F. For example, 100 gallons of automotive combat gasoline (group 3) at an observed temperature of 80° F. is converted to corresponding volume at 60° F. by multiplying by the factor 0.9879. The result is 98.79 gallons at 60° F.

Volume Correction Table for Petroleum Products

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.							
	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.9° API	89.0-93.9° API	94.0-100.0° API
Factor for Reducing Volume to 60° F.								
0	1.0211	1.0241	1.0298	1.0362	1.0419	1.0478	1.0501	1.0532
1	1.0208	1.0237	1.0293	1.0356	1.0412	1.0470	1.0493	1.0523
2	1.0204	1.0233	1.0288	1.0350	1.0405	1.0462	1.0484	1.0514
3	1.0201	1.0229	1.0283	1.0344	1.0399	1.0454	1.0476	1.0506
4	1.0197	1.0225	1.0278	1.0338	1.0392	1.0446	1.0468	1.0497
5	1.0194	1.0221	1.0273	1.0332	1.0385	1.0438	1.0460	1.0488
6	1.0190	1.0217	1.0268	1.0326	1.0378	1.0430	1.0451	1.0479
7	1.0186	1.0213	1.0263	1.0320	1.0371	1.0423	1.0443	1.0470
8	1.0183	1.0209	1.0258	1.0314	1.0364	1.0415	1.0435	1.0462
9	1.0179	1.0205	1.0253	1.0308	1.0357	1.0407	1.0427	1.0453
10	1.0176	1.0201	1.0248	1.0302	1.0350	1.0399	1.0418	1.0444
11	1.0172	1.0197	1.0243	1.0296	1.0343	1.0391	1.0410	1.0435

12	1.0169	1.0193	1.0238	1.0290	1.0336	1.0383	1.0402	1.0427
13	1.0165	1.0189	1.0233	1.0284	1.0329	1.0375	1.0393	1.0418
14	1.0162	1.0185	1.0228	1.0278	1.0322	1.0367	1.0385	1.0409
15	1.0158	1.0181	1.0223	1.0272	1.0315	1.0359	1.0377	1.0400
16	1.0155	1.0177	1.0218	1.0266	1.0308	1.0351	1.0369	1.0391
17	1.0151	1.0173	1.0214	1.0260	1.0301	1.0343	1.0360	1.0383
18	1.0148	1.0168	1.0209	1.0253	1.0294	1.0336	1.0352	1.0374
19	1.0144	1.0164	1.0204	1.0247	1.0287	1.0328	1.0344	1.0365
20	1.0141	1.0160	1.0199	1.0241	1.0280	1.0320	1.0335	1.0356
21	1.0137	1.0156	1.0194	1.0235	1.0273	1.0312	1.0327	1.0347
22	1.0133	1.0152	1.0189	1.0229	1.0266	1.0304	1.0319	1.0338
23	1.0130	1.0148	1.0184	1.0223	1.0259	1.0296	1.0310	1.0330
24	1.0126	1.0144	1.0179	1.0217	1.0253	1.0288	1.0302	1.0321
25	1.0123	1.0140	1.0174	1.0211	1.0246	1.0280	1.0294	1.0312
26	1.0119	1.0136	1.0169	1.0205	1.0239	1.0272	1.0285	1.0303
27	1.0116	1.0132	1.0164	1.0199	1.0232	1.0264	1.0277	1.0294
28	1.0112	1.0128	1.0159	1.0193	1.0225	1.0256	1.0269	1.0285
29	1.0109	1.0124	1.0154	1.0187	1.0218	1.0248	1.0260	1.0276
30	1.0105	1.0120	1.0149	1.0181	1.0211	1.0240	1.0252	1.0268
31	1.0102	1.0116	1.0144	1.0175	1.0204	1.0232	1.0244	1.0259

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.							
	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.9° API	89.0-93.9° API	94.0-100.0° API
Factor for Reducing Volume to 60° F.								
32	1.0098	1.0112	1.0139	1.0169	1.0197	1.0224	1.0235	1.0250
33	1.0095	1.0108	1.0134	1.0163	1.0190	1.0216	1.0227	1.0241
34	1.0091	1.0104	1.0129	1.0157	1.0183	1.0208	1.0219	1.0232
35	1.0088	1.0100	1.0124	1.0151	1.0176	1.0200	1.0210	1.0223
36	1.0084	1.0096	1.0119	1.0145	1.0169	1.0192	1.0202	1.0214
37	1.0081	1.0092	1.0114	1.0139	1.0162	1.0184	1.0193	1.0205
38	1.0077	1.0088	1.0109	1.0132	1.0155	1.0176	1.0185	1.0197
39	1.0074	1.0084	1.0104	1.0127	1.0148	1.0168	1.0177	1.0188
40	1.0070	1.0080	1.0099	1.0122	1.0141	1.0160	1.0168	1.0179
41	1.0067	1.0076	1.0094	1.0115	1.0134	1.0152	1.0160	1.0170
42	1.0063	1.0072	1.0089	1.0109	1.0127	1.0144	1.0152	1.0161
43	1.0060	1.0068	1.0084	1.0103	1.0120	1.0136	1.0143	1.0152

44	1.0056	1.0064	1.0079	1.0097	1.0113	1.0128	1.0135	1.0143
45	1.0053	1.0060	1.0075	1.0091	1.0106	1.0120	1.0126	1.0134
46	1.0049	1.0056	1.0070	1.0085	1.0099	1.0112	1.0118	1.0125
47	1.0046	1.0052	1.0065	1.0079	1.0091	1.0104	1.0110	1.0116
48	1.0042	1.0048	1.0060	1.0073	1.0084	1.0096	1.0101	1.0107
49	1.0038	1.0044	1.0055	1.0067	1.0077	1.0088	1.0093	1.0099
50	1.0035	1.0040	1.0050	1.0061	1.0070	1.0080	1.0084	1.0090
51	1.0031	1.0036	1.0045	1.0054	1.0063	1.0072	1.0076	1.0081
52	1.0028	1.0032	1.0040	1.0048	1.0056	1.0064	1.0067	1.0072
53	1.0024	1.0028	1.0035	1.0042	1.0049	1.0056	1.0059	1.0063
54	1.0021	1.0024	1.0030	1.0036	1.0042	1.0048	1.0051	1.0054
55	1.0017	1.0020	1.0025	1.0030	1.0035	1.0040	1.0042	1.0045
56	1.0014	1.0016	1.0020	1.0024	1.0028	1.0032	1.0034	1.0036
57	1.0010	1.0012	1.0015	1.0018	1.0021	1.0024	1.0025	1.0027
58	1.0007	1.0008	1.0010	1.0012	1.0014	1.0016	1.0017	1.0018
59	1.0003	1.0004	1.0005	1.0006	1.0007	1.0008	1.0008	1.0009
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9997	0.9996	0.9995	0.9994	0.9993	0.9992	0.9992	0.9991
62	0.9993	0.9992	0.9990	0.9988	0.9986	0.9984	0.9983	0.9982
63	0.9990	0.9988	0.9985	0.9982	0.9979	0.9976	0.9975	0.9973

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.							
	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.9° API	89.0-93.9° API	94.0-100.0° API
Factor for Reducing Volume to 60° F.								
64	0.9986	0.9984	0.9980	0.9976	0.9972	0.9968	0.9966	0.9964
65	0.9983	0.9980	0.9975	0.9970	0.9965	0.9960	0.9958	0.9955
66	0.9979	0.9976	0.9970	0.9964	0.9958	0.9952	0.9949	0.9946
67	0.9976	0.9972	0.9965	0.9958	0.9951	0.9944	0.9941	0.9937
68	0.9972	0.9968	0.9960	0.9951	0.9944	0.9935	0.9932	0.9928
69	0.9969	0.9964	0.9955	0.9945	0.9936	0.9927	0.9924	0.9919
70	0.9965	0.9960	0.9950	0.9939	0.9929	0.9919	0.9915	0.9910
71	0.9962	0.9956	0.9945	0.9933	0.9922	0.9911	0.9907	0.9901
72	0.9958	0.9952	0.9940	0.9927	0.9915	0.9903	0.9898	0.9892
73	0.9955	0.9948	0.9935	0.9921	0.9908	0.9895	0.9890	0.9883
74	0.9951	0.9944	0.9930	0.9915	0.9901	0.9887	0.9881	0.9874

75	0.9948	0.9940	0.9925	0.9909	0.9894	0.9879	0.9873	0.9865
76	0.9944	0.9936	0.9920	0.9903	0.9887	0.9871	0.9864	0.9856
77	0.9941	0.9932	0.9916	0.9897	0.9880	0.9863	0.9856	0.9847
78	0.9937	0.9929	0.9911	0.9891	0.9873	0.9855	0.9847	0.9838
79	0.9934	0.9925	0.9906	0.9885	0.9866	0.9846	0.9839	0.9829
80	0.9930	0.9921	0.9901	0.9879	0.9859	0.9838	0.9830	0.9820
81	0.9927	0.9917	0.9896	0.9873	0.9851	0.9830	0.9822	0.9811
82	0.9923	0.9913	0.9891	0.9866	0.9844	0.9822	0.9813	0.9802
83	0.9920	0.9909	0.9886	0.9860	0.9837	0.9814	0.9805	0.9792
84	0.9916	0.9905	0.9881	0.9854	0.9830	0.9806	0.9796	0.9783
85	0.9913	0.9901	0.9876	0.9848	0.9823	0.9798	0.9788	0.9774
86	0.9909	0.9897	0.9871	0.9842	0.9816	0.9790	0.9779	0.9765
87	0.9906	0.9893	0.9866	0.9836	0.9809	0.9881	0.9771	0.9756
88	0.9902	0.9889	0.9861	0.9830	0.9802	0.9773	0.9762	0.9747
89	0.9899	0.9885	0.9856	0.9824	0.9795	0.9765	0.9753	0.9738
90	0.9896	0.9881	0.9851	0.9818	0.9787	0.9757	0.9745	0.9729
91	0.9892	0.9877	0.9846	0.9812	0.9780	0.9749	0.9736	0.9720
92	0.9889	0.9873	0.9841	0.9806	0.9773	0.9741	0.9728	0.9711
93	0.9885	0.9869	0.9836	0.9799	0.9766	0.9733	0.9719	0.9702
94	0.9882	0.9865	0.9831	0.9793	0.9759	0.9724	0.9711	0.9693

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.							
	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.9° API	89.0-93.9° API	94.0-100.0° API
Factor for Reducing Volume to 60° F.								
95	0.9878	0.9861	0.9826	0.9787	0.9752	0.9716	0.9702	0.9683
96	0.9875	0.9857	0.9821	0.9781	0.9745	0.9708	0.9694	0.9674
97	0.9871	0.9854	0.9816	0.9775	0.9738	0.9700	0.9685	0.9665
98	0.9868	0.9850	0.9811	0.9769	0.9731	0.9692	0.9676	0.9656
99	0.9864	0.9846	0.9806	0.9763	0.9723	0.9684	0.9668	0.9647
100	0.9861	0.9842	0.9801	0.9757	0.9716	0.9675	0.9659	0.9638
101	0.9857	0.9838	0.9796	0.9751	0.9709	0.9667	0.9651	0.9629
102	0.9854	0.9834	0.9791	0.9745	0.9702	0.9659	0.9642	0.9620
103	0.9851	0.9830	0.9786	0.9738	0.9695	0.9651	0.9633	0.9610
104	0.9847	0.9826	0.9781	0.9732	0.9688	0.9643	0.9625	0.9601
105	0.9844	0.9822	0.9776	0.9726	0.9681	0.9634	0.9616	0.9592
106	0.9840	0.9818	0.9771	0.9720	0.9673	0.9626	0.9608	0.9583

107	0.9837	0.9814	0.9766	0.9714	0.9666	0.9618	0.9599	0.9574
108	0.9833	0.9810	0.9761	0.9708	0.9659	0.9610	0.9590	0.9565
109	0.9830	0.9806	0.9756	0.9702	0.9652	0.9602	0.9582	0.9555
110	0.9826	0.9803	0.9751	0.9696	0.9645	0.9593	0.9573	0.9546
111	0.9823	0.9799	0.9746	0.9690	0.9638	0.9585	0.9565	0.9537
112	0.9819	0.9795	0.9741	0.9683	0.9630	0.9577	0.9556	0.9528
113	0.9816	0.9791	0.9736	0.9677	0.9623	0.9569	0.9547	0.9519
114	0.9813	0.9787	0.9731	0.9671	0.9616	0.9561	0.9539	0.9510
115	0.9809	0.9783	0.9726	0.9665	0.9609	0.9552	0.9530	0.9500
116	0.9806	0.9779	0.9721	0.9659	0.9602	0.9544	0.9521	0.9491
117	0.9802	0.9775	0.9717	0.9653	0.9595	0.9536	0.9513	0.9482
118	0.9799	0.9771	0.9712	0.9647	0.9587	0.9528	0.9504	0.9473
119	0.9795	0.9767	0.9707	0.9641	0.9580	0.9519	0.9495	0.9464
120	0.9729	0.9763	0.9702	0.9634	0.9573	0.9511	0.9487	0.9454
121	0.9788	0.9760	0.9697	0.9628	0.9566	0.9503	0.9478	0.9445
122	0.9785	0.9756	0.9692	0.9622	0.9559	0.9495	0.9469	0.9436
123	0.9782	0.9752	0.9687	0.9616	0.9552	0.9487	0.9461	0.9427
124	0.9778	0.9748	0.9682	0.9610	0.9544	0.9478	0.9452	0.9418
125	0.9775	0.9744	0.9677	0.9604	0.9537	0.9470	0.9443	0.9408
126	0.9771	0.9740	0.9672	0.9598	0.9530	0.9462	0.9435	0.9399

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.						
	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.0° API	89.0-93.9° API
							94.0-100.0° API
	Factor for Reducing Volume to 60° F.						
127	0.9768	0.9736	0.9667	0.9592	0.9523	0.9454	0.9426
128	0.9764	0.9732	0.9662	0.9585	0.9516	0.9445	0.9417
129	0.9761	0.9728	0.9657	0.9579	0.9508	0.9437	0.9409
130	0.9758	0.9725	0.9652	0.9573	0.9501	0.9429	0.9400
131	0.9754	0.9721	0.9647	0.9567	0.9494	0.9420	0.9391
132	0.9751	0.9717	0.9642	0.9561	0.9487	0.9412	0.9383
133	0.9747	0.9713	0.9637	0.9555	0.9480	0.9404	0.9374
134	0.9744	0.9709	0.9632	0.9549	0.9472	0.9396	0.9365
135	0.9740	0.9705	0.9627	0.9542	0.9465	0.9387	0.9357
136	0.9737	0.9701	0.9622	0.9536	0.9458	0.9379	0.9348
137	0.9734	0.9697	0.9617	0.9530	0.9451	0.9371	0.9339
138	0.9730	0.9693	0.9612	0.9524	0.9444	0.9362	0.9330

139	0.9727	0.9690	0.9607	0.9518	0.9436	0.9354	0.9322	0.9279
140	0.9723	0.9686	0.9602	0.9512	0.9429	0.9346	0.9313	0.9270
141	0.9720	0.9682	0.9597	0.9506	0.9422	0.9338	0.9304	0.9260
142	0.9716	0.9678	0.9592	0.9499	0.9415	0.9329	0.9296	0.9251
143	0.9713	0.9674	0.9587	0.9493	0.9407	0.9321	0.9287	0.9242
144	0.9710	0.9670	0.9582	0.9487	0.9400	0.9313	0.9278	0.9232
145	0.9706	0.9666	0.9577	0.9481	0.9393	0.9304	0.9269	0.9223
146	0.9703	0.9662	0.9572	0.9475	0.9386	0.9296	0.9261	0.9214
147	0.9699	0.9659	0.9567	0.9469	0.9379	0.9288	0.9252	0.9204
148	0.9696	0.9655	0.9562	0.9462	0.9371	0.9279	0.9243	0.9195
149	0.9693	0.9651	0.9557	0.9456	0.9364	0.9271	0.9234	0.9186
150	0.9689	0.9647	0.9552	0.9450	0.9357	0.9263	0.9226	0.9177

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.				Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.			
	Group 0	Group 1	Group 2	Group 3		Group 0	Group 1	Group 2	Group 3
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API		0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API
	Factor for Reducing Volume to 60° F.					Factor for Reducing Volume to 60° F.			
150	0.9689	0.9647	0.9552	0.9450	200	0.9520	0.9456	0.9303	
151	0.9686	0.9643	0.9547	0.9444	201	0.9516	0.9452	0.9298	
152	0.9682	0.9639	0.9542	0.9438	202	0.9513	0.9448	0.9293	
153	0.9679	0.9635	0.9537	0.9432	203	0.9509	0.9444	0.9288	
154	0.9675	0.9632	0.9532	0.9426	204	0.9506	0.9441	0.9283	
155	0.9672	0.9628	0.9527	0.9419	205	0.9503	0.9437	0.9278	
156	0.9669	0.9624	0.9522	0.9413	206	0.9499	0.9433	0.9273	
157	0.9665	0.9620	0.9517	0.9407	207	0.9496	0.9429	0.9268	
158	0.9662	0.9616	0.9512	0.9401	208	0.9493	0.9425	0.9263	
159	0.9658	0.9612	0.9507	0.9395	209	0.9489	0.9422	0.9258	
160	0.9655	0.9609	0.9502	0.9389	210	0.9486	0.9418	0.9253	

161	0.9652	0.9605	0.9497	0.9382	211	0.9483	0.9414	0.9248
162	0.9648	0.9601	0.9492	0.9376	212	0.9479	0.9410	0.9243
163	0.9645	0.9597	0.9487	0.9370	213	0.9476	0.9407	0.9238
164	0.9641	0.9593	0.9482	0.9364	214	0.9472	0.9403	0.9233
165	0.9638	0.9589	0.9477	0.9358	215	0.9469	0.9399	0.9228
166	0.9635	0.9585	0.9472	0.9351	216	0.9466	0.9395	0.9223
167	0.9631	0.9582	0.9467	0.9345	217	0.9462	0.9391	0.9218
168	0.9628	0.9578	0.9462	0.9339	218	0.9459	0.9388	0.9213
169	0.9624	0.9574	0.9457	0.9333	219	0.9456	0.9384	0.9208
170	0.9621	0.9570	0.9452	0.9327	220	0.9452	0.9380	0.9203
171	0.9618	0.9566	0.9447	0.9321	221	0.9449	0.9376	0.9198
172	0.9614	0.9562	0.9442	0.9314	222	0.9446	0.9373	0.9193
173	0.9611	0.9559	0.9437	0.9308	223	0.9442	0.9369	0.9188
174	0.9607	0.9555	0.9432	0.9302	224	0.9439	0.9365	0.9183
175	0.9604	0.9551	0.9428	0.9296	225	0.9436	0.9361	0.9178
176	0.9601	0.9547	0.9423	0.9290	226	0.9432	0.9358	0.9173
177	0.9597	0.9543	0.9418	0.9283	227	0.9429	0.9354	0.9168
178	0.9594	0.9539	0.9413	0.9277	228	0.9426	0.9350	0.9163
179	0.9590	0.9536	0.9408	0.9271	229	0.9422	0.9346	0.9158
180	0.9587	0.9532	0.9403	0.9265	230	0.9419	0.9343	0.9153

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.				Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.			
	Group 0	Group 1	Group 2	Group 3		Group 0	Group 1	Group 2	Group 3
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API		0-14.9° API	15.0-34.9° API	15.0-34.9° API	35.0-50.9° API
	Factor for Reducing Volume to 60° F.								
181	0.9584	0.9528	0.9398	0.9259	231	0.9416	0.9339	0.9339	0.9148
182	0.9580	0.9524	0.9393	0.9252	232	0.9412	0.9335	0.9335	0.9143
183	0.9577	0.9520	0.9388	0.9246	233	0.9409	0.9331	0.9331	0.9138
184	0.9574	0.9517	0.9383	0.9240	234	0.9405	0.9328	0.9328	0.9133
185	0.9570	0.9513	0.9378	0.9234	235	0.9402	0.9324	0.9324	0.9128
186	0.9567	0.9509	0.9373	0.9228	236	0.9399	0.9320	0.9320	0.9123
187	0.9563	0.9505	0.9368	0.9221	237	0.9395	0.9316	0.9316	0.9118
188	0.9560	0.9501	0.9363	0.9215	238	0.9392	0.9313	0.9313	0.9113
189	0.9557	0.9498	0.9358	0.9209	239	0.9389	0.9309	0.9309	0.9108
190	0.9553	0.9494	0.9353	0.9203	240	0.9385	0.9305	0.9305	0.9103
191	0.9550	0.9490	0.9348	0.9197	241	0.9382	0.9301	0.9301	0.9098

192	0.9547	0.9486	0.9343	0.9190	242	0.9379	0.9298	0.9093
193	0.9543	0.9482	0.9338	0.9184	243	0.9375	0.9294	0.9088
194	0.9540	0.9478	0.9333	0.9178	244	0.9372	0.9290	0.9083
195	0.9536	0.9475	0.9328	0.9172	245	0.9369	0.9286	0.9078
196	0.9533	0.9471	0.9323	0.9166	246	0.9365	0.9283	0.9073
197	0.9530	0.9467	0.9318	0.9159	247	0.9362	0.9279	0.9068
198	0.9526	0.9463	0.9313	0.9153	248	0.9359	0.9275	0.9063
199	0.9523	0.9460	0.9308	0.9147	249	0.9356	0.9272	0.9058
200	0.9520	0.9456	0.9303	0.9141	250	0.9352	0.9268	0.9053

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
250	0.9352	0.9268
251	0.9349	0.9264
252	0.9346	0.9260
253	0.9342	0.9257
254	0.9339	0.9253
255	0.9336	0.9249
256	0.9332	0.9245
257	0.9329	0.9242
258	0.9326	0.9238
259	0.9322	0.9234
260	0.9319	0.9231
261	0.9316	0.9227
262	0.9312	0.9223
263	0.9309	0.9219
264	0.9306	0.9216
265	0.9302	0.9212
266	0.9299	0.9208
267	0.9296	0.9205
268	0.9293	0.9201
269	0.9289	0.9197
270	0.9286	0.9194
271	0.9283	0.9190
272	0.9279	0.9186
273	0.9276	0.9182
274	0.9273	0.9179
275	0.9269	0.9175

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
276	0.9266	0.9171
277	0.9263	0.9168
278	0.9259	0.9164
279	0.9256	0.9160
280	0.9253	0.9157
281	0.9250	0.9153
282	0.9246	0.9149
283	0.9243	0.9146
284	0.9240	0.9142
285	0.9236	0.9138
286	0.9233	0.9135
287	0.9230	0.9131
288	0.9227	0.9127
289	0.9223	0.9124
290	0.9220	0.9220
291	0.9217	0.9116
292	0.9213	0.9113
293	0.9210	0.9109
294	0.9207	0.9105
295	0.9204	0.9102
296	0.9200	0.9098
297	0.9197	0.9094
298	0.9194	0.9091
299	0.9190	0.9087
300	0.9187	0.9083
301	0.9184	0.9080

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
302	0.9181	0.9076
303	0.9177	0.9072
304	0.9174	0.9069
305	0.9171	0.9065
306	0.9167	0.9061
307	0.9164	0.9058
308	0.9161	0.9054
309	0.9158	0.9050
310	0.9154	0.9047
311	0.9151	0.9043
312	0.9148	0.9039
313	0.9145	0.9036
314	0.9141	0.9032
315	0.9138	0.9029
316	0.9135	0.9025
317	0.9132	0.9021
318	0.9128	0.9018
319	0.9125	0.9014
320	0.9122	0.9010
321	0.9118	0.9007
322	0.9115	0.9003
323	0.9112	0.9000
324	0.9109	0.8996
325	0.9105	0.8992
326	0.9102	0.8989
327	0.9099	0.8985

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
328	0.9096	0.8981
329	0.9092	0.8978
330	0.9089	0.8974
331	0.9086	0.8971
332	0.9083	0.8967
333	0.9079	0.8963
334	0.9076	0.8960
335	0.9073	0.8956
336	0.9070	0.8952
337	0.9066	0.8949
338	0.9063	0.8945
339	0.9060	0.8942
340	0.9057	0.8938
341	0.9053	0.8934
342	0.9050	0.8931
343	0.9047	0.8927
344	0.9044	0.8924
345	0.9040	0.8920
346	0.9037	0.8916
347	0.9034	0.8913
348	0.9031	0.8909
349	0.9028	0.8906
350	0.9024	0.8902
351	0.9021	0.8899
352	0.9018	0.8895
353	0.9015	0.8891

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
354	0.9011	0.8888
355	0.9008	0.8884
356	0.9005	0.8881
357	0.9002	0.8877
358	0.8998	0.8873
359	0.8995	0.8870
360	0.8992	0.8866
361	0.8989	0.8863
362	0.8986	0.8859
363	0.8982	0.8856
364	0.8979	0.8852
365	0.8976	0.8848
366	0.8973	0.8845
367	0.8969	0.8841
368	0.8966	0.8838
369	0.8963	0.8834
370	0.8960	0.8831
371	0.8957	0.8827
372	0.8953	0.8823
373	0.8950	0.8820
374	0.8947	0.8816
375	0.8944	0.8813
376	0.8941	0.8809
377	0.8937	0.8806
378	0.8934	0.8802
379	0.8931	0.8799

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
380	0.8928	0.8795
381	0.8924	0.8792
382	0.8921	0.8788
383	0.8918	0.8784
384	0.8915	0.8781
385	0.8912	0.8777
386	0.8908	0.8774
387	0.8905	0.8770
388	0.8902	0.8767
389	0.8899	0.8763
390	0.8896	0.8760
391	0.8892	0.8756
392	0.8889	0.8753
393	0.8886	0.8749
394	0.8883	0.8746
395	0.8880	0.8742
396	0.8876	0.8738
397	0.8873	0.8735
398	0.8870	0.8731
399	0.8867	0.8728
400	0.8864	0.8724
401	0.8861	0.8721
402	0.8857	0.8717
403	0.8854	0.8714
404	0.8851	0.8710
405	0.8848	0.8707

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60°F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
406	0.8845	0.8703
407	0.8841	0.8700
408	0.8838	0.8696
409	0.8835	0.8693
410	0.8832	0.8689
411	0.8829	0.8686
412	0.8826	0.8682
413	0.8822	0.8679
414	0.8819	0.8675
415	0.8816	0.8672
416	0.8813	0.8668
417	0.8810	0.8665
418	0.8806	0.8661
419	0.8803	0.8658
420	0.8800	0.8654
421	0.8797	0.8651
422	0.8794	0.8647
423	0.8791	0.8644
424	0.8787	0.8640
425	0.8784	0.8637
426	0.8781	0.8633
427	0.8778	0.8630
428	0.8775	0.8626
429	0.8772	0.8623
430	0.8768	0.8619
431	0.8765	0.8616

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
432	0.8762	0.8612
433	0.8759	0.8609
434	0.8756	0.8605
435	0.8753	0.8602
436	0.8749	0.8599
437	0.8746	0.8595
438	0.8743	0.8592
439	0.8740	0.8588
440	0.8737	0.8585
441	0.8734	0.8581
442	0.8731	0.8578
443	0.8727	0.8574
444	0.8724	0.8571
445	0.8721	0.8567
446	0.8718	0.8564
447	0.8715	0.8560
448	0.8712	0.8557
449	0.8709	0.8554
450	0.8705	0.8550
451	0.8702	0.8547
452	0.8699	0.8543
453	0.8696	0.8540
454	0.8693	0.8536
455	0.8690	0.8533
456	0.8687	0.8529
457	0.8683	0.8526

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
458	0.8680	0.8522
459	0.8677	0.8519
460	0.8674	0.8516
461	0.8671	0.8512
462	0.8668	0.8509
463	0.8665	0.8505
464	0.8661	0.8502
465	0.8658	0.8498
466	0.8655	0.8495
467	0.8652	0.8492
468	0.8649	0.8488
469	0.8646	0.8485
470	0.8643	0.8481
471	0.8640	0.8478
472	0.8636	0.8474
473	0.8633	0.8471
474	0.8630	0.8468
475	0.8627	0.8464
476	0.8624	0.8461
477	0.8621	0.8457
478	0.8618	0.8454
479	0.8615	0.8451
480	0.8611	0.8447
481	0.8608	0.8444

Volume Correction Table—Continued

Observed Temperature, °F.	Group Number and API Gravity Range at 60° F.	
	Group 0	Group 1
	0-14.9° API	15.0-34.9° API
	Factor for Reducing Volume to 60° F.	
482	0.8605	0.8440
483	0.8602	0.8437
484	0.8599	0.8433
485	0.8596	0.8430
486	0.8593	0.8427
487	0.8590	0.8423
488	0.8587	0.8420
489	0.8583	0.8416
490	0.8580	0.8413
491	0.8577	0.8410
492	0.8574	0.8406
493	0.8571	0.8403
494	0.8568	0.8399
495	0.8565	0.8396
496	0.8562	0.8393
497	0.8559	0.8389
498	0.8556	0.8386
499	0.8552	0.8383
500	0.8549	0.8379

GLOSSARY

1. Abbreviations

API—American Petroleum Institute.

ASTM—American Society for Testing Materials.

bph.—Barrels per hour

B. T. U.—British thermal unit. It is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at its point of maximum density.

cc—Cubic centimeter (identical with *ml*).

fps—Feet per second.

gpm—Gallons per minute.

ml—Milliliter (identical with *cc*). One thousandth of a liter.

POL—The military abbreviation for petroleum products. From the British: Petrol, Oil, Lubricants. A term signifying petroleum and/or petroleum products.

psi—Pounds per square inch.

rpm—Revolutions per minute.

SAE—Society of Automotive Engineers.

2. Definitions

Ash content—The amount of noncombustible material, such as silica and metal compounds in petroleum products.

Aviation gasoline—Gasoline made especially for piston aircraft engines. It has a relatively high octane rating and a distillation range between 129° F. and 338° F.

Barrel—A measure of the volume of liquid petroleum products equal to 42 U. S. gallons at 60° F. Not to be confused with *drum* (as the standard military 55-gallon drum).

Base terminal—Upstream terminal of a pipeline, usually a port where tankers are unloaded. Principal bulk storage location.

Batch—A specific volume of a certain product pumped into and through a line in one continuous operation, usually preceded and followed by a different type product.

Black oil—The trade name for petroleum products which cannot be handled in the same pipeline or tanker as more highly refined oils. Such products are low-grade diesel fuel, road oils, and furnace or bunker oils. Contrast, *white oil*.

Blended fuel—A fuel oil which is a mixture of two or more fuels, such as residual, distillate, or cracked.

Blending—The process whereby two or more components of like nature are mixed, such as mixing a light and heavy lubricating oil to make a blend of medium viscosity.

Boiling point—The temperature at which a substance begins to boil or to be converted into vapors. It varies with atmospheric pressure for any substance. Under ordinary conditions, namely, at sea level, it is 212° F. for water. The boiling point decreases with lessening atmospheric pressure, as in ascending a mountain, falling about one degree Fahrenheit for every 550 feet of ascent.

Booster station—A pump station used to boost the discharge from tanker pumps to base-terminal storage.

Branch station—Pump station on a branch pipeline.

Bright stock—A term, used in the petroleum industry, which is applied to a highly refined and heavy lubricating oil.

Bulk products—Petroleum products transported and stored in pipelines, tankers, barges, rail tank cars, and tank trucks.

Bull plug—Blank-end pipe fitting used to close an open pipe end or pipefitting opening.

Bunker fuel—Fuel oil carried on oil-burning ships for their own use.

Butane—A saturated hydrocarbon found in petroleum which exists as a gas above, and as a liquid below, 32° F. at normal atmospheric pressure.

Carbon—A chemical element occurring in all organic compounds, such as coal, oil, or wood. Pure carbon is crystalline, as in diamonds, or noncrystalline, as in lampblack.

Carbon residue—The carbon deposit left after all of an oil has been strongly heated and volatilized in the absence of air.

Carbon tetrachloride—A colorless, heavy, non-flammable liquid used in fire extinguishers.

Cathodic protection—Introducing into a petroleum pipeline, at frequent intervals along the line, externally generated electrical currents of sufficient strength to overpower existing weaker currents

Centigrade—A thermometer scale which shows the freezing point of pure water at 0° and the boiling point at 100°. Used internationally.

Cetane—A saturated liquid hydrocarbon used as the primary reference fuel when determining the ignition quality.

Cetane number—The rating of a diesel fuel which describes its ignition quality.

Chime—The top or bottom flanged edge or rim of a stove sheet for a storage tank or drum.

Clean product—A term, used in the petroleum industry, which is applied to a highly refined product such as gasoline, kerosene, and jet fuel.

Colorimeter—An apparatus used to compare the color of petroleum products with predetermined color standards. There are two main types, Saybolt and ASTM.

Commingle—The mixing of any two or more types or grades of petroleum products.

Composite sample—A mixture of samples taken separately from the upper, middle and lower thirds of a tank's contents.

Composite temperature—The average temperature of the liquid in a bulk container after reading temperatures at upper, middle, and lower levels.

Condensation—The conversion of a vapor to a liquid or solid state.

Cracking—The process of breaking down high molecular weight compounds to form a compound of lower molecular weight by the application of a catalyst and/or heat. The crack-

ing process is applied specifically to petroleum refining.

Crude—Naturally occurring petroleum fluid consisting predominantly of hydrocarbons with or without impurities such as sulfur, nitrogen, or oxygen.

Cut—A fraction directly obtained in the process of distillation.

Deadwood—Internal fittings and fixtures such as boltheads, channels, ladders, and poles, which occupy space in the inside of a tank and thus reduce its storage capacity.

Decant—To remove liquid petroleum products from one type of container to another.

Density—The ratio of the weight of a substance per unit volume to the weight of the same volume of water. The density of petroleum liquid fuel is less than that of water.

Diesel engine—An engine in which the vapor of fuel injected into the engine cylinders under high pressure is ignited by air heated to the ignition point or temperature by compression.

Diesel index—A measure of the ignition quality of a diesel fuel obtained from its API gravity and its aniline point.

Dirty product—A term, used in the petroleum industry, which is applied to residual petroleum products such as asphalt or bunker oil.

Discharge pressure—The pressure at which fluid is discharged from a pumping unit or a pumping station.

Dispensing storage tanks—Tanks from which fuel is dispensed directly to drums, tank vehicles, and vehicle fuel tanks.

Distillate—The collected and condensed vapors of a liquid collected as a result of a distillation process.

Dolphin—A group of piles lashed together for use as a mooring to which ships are fastened.

Downgrade—A grade which slopes downward in the direction of flow in a pipeline. Not to be confused with *downstream*; reclassification or blending of contaminated petroleum product to the next lower quality grade.

Downstream—The direction of flow in a pipeline.

Drum—Container, usually metal, for liquid petroleum products. Most common capacities in Army use are 5 gallons and 55 gallons. Five-gallon drums are usually referred to as *cans*.

Elbow, ell—A fitting that makes an angle between pipes; the angle is always 90° unless otherwise stated.

Emergency head capacity—Pressure in feet of head which a pumping unit produces at maximum rate of discharge.

End point—The final temperature at which the last portion of a product has been vaporized by ASTM distillation methods.

Ethane—A gaseous hydrocarbon of the paraffin series found principally in natural gas and which can be liquified at low temperatures and high pressure.

Ethylene—A colorless gas which is the frequent product of destructive distillation.

Evaporation losses—Losses of fuel due to evaporation. Losses are greatest in the more volatile fractions of the fuel.

Fahrenheit—A thermometer scale which shows the freezing point of pure water at 32° and the boiling point at 212°.

Feeder station—A pumping station used to boost the discharge from tank farms to a pipeline pumping station.

Feet of head—The measure of pressure in terms of the height in feet of a column of a given fluid. This measurement is convenient for use in hydraulic design of pipelines, since it can be applied directly to terrain elevations.

Flash point—The lowest temperature at which an oil or a fuel gives off sufficient vapor to form a mixture that will ignite under standard test conditions. As applied to fuels, *high flash* means that the fuel *flashes* at a relatively high temperature and consequently is comparatively safe to handle. Similarly, *low flash* fuels must be handled carefully because of the fire and explosion hazards.

Fractional distillation — The separation of liquids with different boiling points by applying heat. This process is applied specifically to petroleum refining.

Gaging—Measuring the contents of storage tanks by determining the height of liquid level above the tank bottom (innage gage) or the distance between the liquid level and the

top of the tank (outage gage). Volume of contents is then determined from gaging tables compiled by strapping the tank.

Gas oil—A distilled petroleum fraction which has a boiling range above that of kerosene and a viscosity between kerosene and lubricating oil.

Gravity, API—The gravity scale developed by the American Petroleum Institute to express the density of liquid petroleum products.

Gravity, specific—The ratio of the weight of a substance per unit volume to the weight of the same volume of water. The specific gravity of substances lighter than water, such as petroleum liquid fuels, is less than 1.0.

Header—A common source or terminus; a manifold; a section of pipe having many inflowing and outflowing lines.

Head terminal—Tank farm installation at a pipehead.

High-test gasoline—This term is applied to gasoline which has an especially high anti-knock rating. Such gasoline generally contains large amounts of cracked gasoline and, frequently, tetraethyl lead compounds.

Hydrocarbon—A chemical compound of hydrogen and carbon in various combinations. Petroleum products are hydrocarbons.

Hydrogen—A colorless, tasteless, odorless, and flammable gaseous element which is lighter than any other known substance.

Hydrometer—An instrument used to determine the specific gravity of a liquid.

Incremental pressure—The difference between the suction and discharge pressure of a pump.

Innage—The volume of liquid present in a storage tank.

Interface—The plane of contact between successive tenders of dissimilar fuels in a pipeline. Ideally, the interface would be a plane. Actually, the dissimilar products contaminate each other on both sides of the theoretical interface, forming a *mixed plug*.

Iso-octane—A hydrocarbonate showing an octane number of 100 and used as a reference fuel in determining the octane number of a fuel under test.

Joint—The junction of two pieces of pipe. Also, a standard length of pipe, usually 20 feet.

Kerosene—A petroleum distillate with a boiling range from approximately 350° to 572° F.

Knock test—A test made to determine the octane number of gasoline. A measure of the antiknock value of gasoline.

Line—The pipe and supporting structures of a pipeline between installations.

Looped line—A doubled pipeline constructed for the purpose of increasing capacity or reducing pressure losses. Also, an alternate section of pipeline built around a break or a point of potential damage, such as a river crossing, to restore or maintain operations during repairs.

Manifold—Assembly of pipe and fittings containing several branches for conducting flow from several lines into one line, or vice versa.

Marker buoy—A small buoy used to mark the end of a submarine pipeline tanker unloading hose.

Maximum head capacity—See *Emergency head capacity*.

Melting point—The temperature at which a solid substance melts or fuses.

Methane—An odorless and flammable gaseous hydrocarbon which forms the principal constituent of natural gas. It can be liquified at exceedingly low temperatures and high pressure. Methane is sometimes known as march gas or firedamp.

Mixed plug—The volume of fluid between two tenders of dissimilar fluids which consists of a mixture of both fluids.

Normal head capacity—Pressure in feet of head of fluid which a pumping unit will produce at the most efficient rate of discharge.

Octane number—The designation adapted to show the antiknock value of a motor fuel. Actually, it is the percentage of iso-octane in a blend of iso-octane and normal heptane which will give the same antiknock characteristic as the fuel sample in question.

Outage—The volume of a free space present in a storage tank.

OWG pipe fitting—A standard fitting that can be used for oil, water, and gas. Same as *WOG pipe fitting*.

Packaged products—Petroleum products stored transported, and issued in cans, drums, and similar containers, as distinguished from bulk products.

Paper (water finding)—Sensitized paper used when gaging to show the level of water in a storage tank containing a petroleum product.

Parallel connection—Connection of pumps for increased volume at a given pressure. Pumps of equal capacity will contribute equal shares to the output volume while the pressure remains equal to that of one pump.

Pentane—A low boiling hydrocarbon and one of the constituents of ordinary gasoline. This hydrocarbon is a liquid up to 97° F. and a gas above this temperature when under normal atmospheric pressure.

Pipehead—The supply point at which petroleum products are taken from a pipeline for storage, distribution, or forwarding by another means of transportation.

Pipeline—A single line of pipe, pumps, tanks, and other equipment used to transport liquid petroleum products.

Pipeline system—One or more pipelines with appurtenances organized and operated by the same controlling headquarters.

Pour point—The lowest temperature at which oil will pour or flow when it is chilled without disturbance under definitive prescribed conditions. By ASTM instructions, it is taken as the temperature 5° F. above the solid point.

Propane—A hydrocarbon found principally in natural gas or light petroleum fractions. Under normal atmospheric pressure and temperatures, propane exists as a gas. It liquefies under high pressure and low temperature.

Pumps in parallel—An arrangement for connecting two or more pumps to operate at the same suction pressure with their total output equal to the sum of the individual pump outputs. The discharge pressure is equal to that of one pump. This arrangement permits handling of large volumes of liquid at low pressure.

Pumps in series—An arrangement for connecting two or more pumps to operate at the same output. The total available discharge pressure is equal to the sum of the individual pump pressures. The output is equal to that of one pump. This arrangement permits the handling of small volume of fluid at high pressure.

Reid vapor pressure—The measure of pressure exerted on the interior of a container through the tendency of the product to vaporize.

SAE number—The number designations developed by the Society of Automotive Engineers to indicate the viscosity range of motor, transmission, and rear axle lubricants.

Series connection—Connection of pumps to produce increased pressure for a given volume. The liquid passes successively from one pump to the next, each pump contributing an increment to the discharge pressure. The volume output is equal to that of one pump.

Spontaneous combustion—The internal development of heat in a substance to the point of ignition.

Squeeze—The building up of the pressure in a

pipeline by means of pumping against a closed valve.

Static electrical discharge—Instantaneous electric discharge, usually a spark, between two charged bodies when the potential difference is large enough to overcome the resistance between them.

Static electricity—Electric potential as distinguished from electric current. Electricity at rest.

Static pressure—Pressure developed by a column of liquid acting by mere weight without motion.

Stoke (centistoke)—A unit of kinematic viscosity.

Straight-run—A term applied to a petroleum product obtained directly from crude petroleum by fractional distillation.

Strapping—Accurate determination of the capacity of storage tanks at regular intervals, taking into account the irregularities in the shape of the tank and the volume of *deadwood* within it.

Suction pressure—The pressure (gage) at which fluid is delivered in a pipeline to the suction or intake side of a pump.

Surge—Irregular flow of liquid in a line. Surging produces uneven shock pressures and consequent vibration. It is particularly prevalent during initial filling of a pipeline but may occur at any time.

Switching—Changing from one tank to another or one product to another when delivering into or receiving fuel from a pipeline.

Tank farm—A group of storage tanks connected by pipe and manifold.

Tender—An amount of a specific product that is to be pumped through a pipeline. When it enters the pipeline it becomes a batch. See *Batch*.

Thief—A vessel or instrument for taking samples of petroleum products from storage containers.

Thief hatch—An opening in the deck of a storage tank through which the contents of the tank are gaged or sampled.

Throughput—The amount of fluid which is put through a pipeline in a given unit of time; e. g., barrels per hour or gallons per minute.

Trap—An apparatus for the separation of one phase from another, as a liquid from a gas.

Triptane—A component of motor fuel which has a higher antiknock value than any other substance produced.

Truck station—A pump station on the main line of a pipeline.

Ullage—The amount by which a tank lacks being full.

Upgrade—A grade which slopes upward in the direction of flow in a pipeline. Not to be confused with *upstream*.

Upstream—The direction opposite to the direction of flow in a pipeline.

Vapor density—Relative weight of a gas or vapor as compared with some standard (such as air).

Vapor lock—Vaporization of liquid in the suction line or pump causing the pump to fail to function.

Vaporization—The change from a liquid to a vapor state, such as the conversion of water to steam.

Viscosimeter—The apparatus used for determining the viscosity of a substance.

Viscosity—The measure of the internal friction of a substance, its resistance to flow. Viscosity varies with temperature; as the temperature rises, viscosity decreases.

Viscosity, kinematic—The ratio of the absolute viscosity of the liquid to its specific gravity at the temperature at which the viscosity is measured.

Viscosity, Saybolt universal—The time in seconds for 60 cc of fluid to flow through a capillary tube in a Saybolt universal viscosimeter at a given temperature.

Viscosity index—An empirical number indicating the effect of temperature change on the viscosity of a liquid petroleum product.

Volatile—Easily vaporizable.

White oil—The trade term for refined petroleum products that can be pumped successively in a pipeline which also pumps gasoline. Among them are gasoline, jet fuel kerosene, high-grade diesel fuel, and No. 2 oil.

WOG pipe fitting—A standard fitting that can be used for water, oil, and gas. Same as *OWG pipe fitting*.

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For explanation of abbreviations used, see AR 320-50.

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